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DELIVERY OF TELEGRAMS.

ANOTHER storm has been raised about the management of the Post Office. No sooner is the vexatious business of the telegraph clerks disposed of, than the attention of the public is brought to bear on the internal working of the telegraph department in regard to the delivery of telegrams.

Prof. George Darwin, towards the end of last week, sent a complaint to the *Times* as to the non-delivery of a telegram. The grievance, in the Professor's own words, is : "A friend recently telegraphed to me from America, addressing the message, 'Darwin, Cambridge,' and it was not delivered on account of insufficient address. He repeated the attempt three times, and I learn from the General Post Office that there are others of my name residing in Cambridge, and that it was impossible to know with certainty for whom the message was intended. The other persons are my brothers. The non-delivery of the message was the occasion of the unnecessary sailing of a friend to America."

There can be little doubt that the Professor's allegation is not altogether well founded, and that the fault lay with his American friend ; but while regretting the circumstance, one might have placed it to the credit of unaccountable accidents from which human beings possess no immunity, had it not been followed by a long series of like complaints. The Professor, as it were, had applied the match, and the explosion resulted in due course. This opening of the subject has given the opportunity for many to air their opinions as to desirable alterations.

Lord Sackville Cecil, in his letter, draws attention to other points besides transmission, which require speedy attention. It is known that telegrams handed in late in the evening at many offices are sometimes kept over until next morning. This is considered by some to be a gross breach of contract on the part of the postal authorities, but people who show a desire to ventilate supposed grievances speak, in most cases, without any knowledge of the regulations affecting the transmission of telegrams. No one thinks of using the telegraph wires except in urgent cases, and if a letter would reach its destination in the same time as a telegram, it is asked, where is its use ? It is, of course, incumbent on the office to see that a message is delivered as quickly as possible, or the official should state frankly to customers that he will not undertake to deliver them the same evening. This course is, we believe, generally pursued, although there may be instances in which the telegraph clerk is as ignorant of the regulations as the sender of the message. It is clearly incumbent upon the public to know in what the contract which is said to be broken really consists, otherwise it is sheer folly to fill the columns of the daily papers with complaints which have no existence in fact.

MANUAL TRAINING.

IN a recent issue of the American journal, "Bradstreet's," a description is given of the School of Manual Training at Baltimore. This institution claims to be the pioneer public manual training school, as well as the only absolutely free school of the sort in the world. The school was opened in 1884 with 60 pupils and 4 teachers ; the scholars now number 549, with 15 instructors. The principal object of the training is the teaching of manual work, the literary instruction, which forms the chief motive of ordinary schools, being here but a department. The teaching of trades is not so much a desideratum as education in the use of tools and the early stages of mechanical industries.

The regular course extends over three years, but a shorter course of two years is suited to those who are unable to go through the longer training.

The daily work comprises instruction in the shops, draught-rooms, physical laboratory, and literary classes. During the first year of training, 15 weeks are devoted

to carpentry, 5 to wood-turning, and 20 to forging. In the second year, 15 weeks are given to pattern making, 5 to moulding, 15 to vice work, and 5 to soldering and brazing. Instruction is given as to the use and care of tools, designing work, and the nature of the materials employed.

Each class makes some special design for graduation, and this year a 10 horse-power dynamo, 13 lathes, and a Gordon printing press, have been undertaken.

The dynamo will be set up, and is expected to furnish a sufficient supply of electrical energy for the lighting of the buildings with incandescence lamps. The students also do all the plating required, and carry out all repairs to the machinery in use in the establishment.

There can be little doubt as to the value of schools of this nature, providing as they do practical instruction, and affording a means by which youngsters, who in after life must depend upon manual work, can readily give their attention to, and be guided in the study of, their individual bent. It would certainly appear desirable that in the higher classes of our Board Schools some attempt in this direction should be made.

Utilisation of Water Power.

IT would seem that the scheme for the utilisation of the Niagara Falls for the purpose of distributing power to a number of factories at Buffalo, has assumed a definite shape. A piece of land some distance above the Falls has been acquired, and a very strong syndicate has taken the work in hand. It is stated that 4 per cent. of the river flow will provide 120,000 horse-power, supposing that a fall of 140 feet is adopted. A lateral canal will carry the water required from the main river to vertical shafts, in which turbines, said to be the largest yet designed, will be placed. The town of Buffalo is 18 miles distant from the Falls, and it is as yet undecided as to the method to be employed in transmitting the power. The choice is not a large one, lying between rope transmission, as at Schaffhausen, compressed air, as at Paris and Birmingham, water pressure, as in London, and electricity. The Cataract Company has invited tenders, and the plans will be submitted to a scientific international committee. Meanwhile, a scheme of considerable magnitude is actually in course of execution at Helena, Montana, where the Missouri Power Company is building an immense dam across the Missouri River for the purpose of utilising the water power. The dam is a timber structure, 800 feet long and 47 feet high, and the reservoir thus formed will cover an area of about 429 square miles. The water will be carried through a tunnel to the turbines, and it is expected that 20,000 horse-power will be generated, the power being then transmitted electrically to the various mills.

How to Advertise.

A REMARKABLE supplement has been issued by our Italian contemporary, *L'Elettricita*. It consists of 24 quarto pages of illustrated matter referring solely to the Thomson-Houston International Company and to their exhibits shown at the Paris Exhibition. There are described the Thomson-Houston dynamo, three wire system of distribution, method of traction, alternate current dynamo, arc and glow lamps, electric welding, &c. In the list referring to the lighting of Europe, the number of towns in which the system is in operation is given as 64, and several installations are to be found in some of these. The arc lamps in use in Europe comprise 3,836 and the incandescent lamps 17,055. Particulars are also given of the extensive use of the system of lighting and traction in America, and of which we gave details some time ago. The number, which, by the way, has only this week been issued as a supplement to one published a fortnight ago, winds up with testimonials, and is unique in the annals of technical advertising.

Cataphoric Medication.

IN the early autumn of last year Dr. Harries and Mr. H. Newman Lawrence made conclusive experiments on this subject and have since carried out this treatment, to which Dr. Harries gave the name of "Cataphoric Medication," in their regular practice at the Institute of Medical Electricity. In Mr. Lawrence's address to the City and Guilds' Old Students Association, published in the REVIEW of December 27th, 1889, he spoke of this treatment as in actual practice, and it is again mentioned in a note on the 8th of this month. Dr. Harries has referred, in his letter to us, to other dates in which he made the matter public.

Cable Testing.

THE letter which we publish from Mr. Cuthbert Hall does not show him in any better light than did his first communication; it was perhaps too much to expect the *amende honorable* from a gentleman whose character is so clearly defined by his writings. His reference to the Marchant engine, and other allusions, show him to be better acquainted with the REVIEW than he at first gave himself credit for; he might have gone further and acknowledged us as being the means of exposing that matter and bringing its career to a prompt and crushing end, but he evidently prefers dealing with half truths, probably under the impression that many of our subscribers may not be acquainted with the circumstances under which this incident took place. It will be noticed that all reference to Glover's and Henley's Works is carefully avoided, and as for the remainder of his remarks, we leave them to the tender mercies of such of our readers as may care to carry the matter further; or to the journal which first gave our correspondent publicity.

Kemmler's Execution.

THE *Scientific American*, of all the transatlantic papers to hand, seems to have taken the fairest and most impartial view of Kemmler's execution. After stating that the apparatus employed was sure and effective and that the criminal was instantly killed, our contemporary argues as follows:—"The most intelligent of the witnesses, disinterested persons, also the warden of the prison, declare that as a mode of execution the electrical plan is far preferable to the scaffold. It is rumoured the Westinghouse Company or some of its adherents spent many thousands of dollars in fruitless efforts to nullify and obstruct the operation of the new law. The ablest lawyers and experts, who ordinarily receive large fees, were employed. The execution of a criminal, whether by the guillotine, the garotte, the gallows, the gun, or the dynamo, is a ghastly business; and it is not surprising that the sensational newspapers, aided by the electrical opponents of the law, should have made the most of such an occasion to fill their columns with revolting details.

The foes of the law dwell upon the fact that the muscular contractions of the victim after the switch was turned prove the correctness of their original position—that Kemmler lingered a few seconds in life, that he was not instantaneously killed, therefore that electricity is a failure for this purpose, and the law should be repealed. We have only to say, if they are not satisfied with the electrical apparatus used at Auburn, if, as they claim, it is not effective, then let us employ the deadly devices which the complainants themselves use, own, and control, with which they fill our streets and slay our innocent citizens. Let them bring the culprit to our city prison, place him on a conducting floor, introduce one of their street light wires, and with it, at the moment of execution, touch the hands of the prisoner. It will extinguish life instantly. It has rarely been known to fail."

Edinburgh Exhibition Awards.

A GOOD deal of disappointment has been caused by the decision of the Executive Council, not to give awards in the electrical departments of the exhibition. We understand that this is in consequence of the London Chamber of Commerce and the Institution of Electrical Engineers refusing to appoint a jury. It is not a usual thing for the Institution to appoint a jury, and if it did not care about the task the exhibition authorities should appoint their own. We are aware that a stipulation was entered into with the London Chamber of Commerce on this matter, but if this body backs out the exhibition officials must look elsewhere. At any rate they should act fairly towards the electrical firms, many of whom may have been induced to exhibit in the hope of obtaining some reward in the shape of prizes. Were it not from the fact that awards were understood to be forthcoming the matter would not be worth discussing, for, after all, the value of exhibition medals or certificates is more apparent than real. Probably it was found impossible to get together a body of experts to undertake a series of exhaustive and lengthy tests without paying heavily for their services, and awards for merely showing apparatus give no legitimate representation of the standard of excellence to which the manufactures of any firm have been brought. As the matter stands the proceedings are calculated to render exhibitors more and more averse to participating in "International" shows, into which they are so frequently entrapped by specious promises made under the cover of high sounding patronage, and from which they apparently reap so little benefit.

Yet Another Alternator.

IN Messrs. Pyke and Harris's letter, which appears in another column, the principle of the new Thomson alternator is claimed afresh. We have examined the patent specification of Pyke and Barnett, and observe that the machine they refer to is indeed similar in principle to that of Prof. Elihu Thomson. In the application of the principle, however, it rather resembles Kingdon's. The lines of force do not pass through the axle, as in Thomson's, the magnetic circuits through adjacent generator coils being completed by inductor segments attached to rotating wheels. We cannot describe the machine in detail without a diagram, but may mention that it has one magnetising coil wound in two sections, four circles of projecting stationary cores with generator coils on them, arranged two concentrically on each side of the magnet, and two magnetic inductor wheels. As we have shown, the application of this principle is at least as old as 1883, probably older; but if there is any inventor prior to Lever, who had similar ideas, he has not yet urged his claim.

An Electrical Patriarch.

IN a circular card, which Messrs. Sydney F. Walker and Co., are sending out, there is attached the following note:—"Our Mr. Sydney F. Walker claims to be the oldest living electric light engineer in the kingdom, if not in the world, he having been electrician to the proprietors of the first dynamo machine that was introduced into this country." Is not the unbounded assurance of this electrical patriarch appalling? Possibly more than one individual in the profession who would be apt to characterise Mr. Walker's work as the production of the oldest electric light engineer on the grounds that it would not reflect too great credit on the youngest; indeed, we have heard on good authority, that his dynamos bear traces of being built on the lines of "the first dynamo that was introduced into this country." This, however, we cannot vouch for, but we would like to hear from Mr. Walker on what he bases his claim, as we know something of "the first dynamo machine that was introduced into this country."

The Telegraph Service.

A MEDICAL man suggests the following remedy for the "address insufficient" grievance, of which those who frequently make use of telegrams are now complaining in the columns of the *Times*:—"Let no message be taken at a telegraph office with a paid reply without receipt of a full and sufficient address from the sender. Let all paid replies be sent to the office whence the first message was issued, and in case of difficulty, let a telegram whose owner cannot be at once found be referred to the post office." The theory that the non-delivery of telegrams is due to the employment of careless boys, whereas letters, which rarely, it is said, miss their destination, are in the hands of experienced and trustworthy men, scarcely explains the matter. If a letter is addressed to "Darwin, Cambridge," the postman probably gives it to the first person of that name he comes across in his rounds, and if it happens to be for another individual, he eventually receives it through the information contained therein. But, in innumerable instances, letters are returned to the sender with "Not known," &c., written across the envelope, so the telegram fault evidently does not lie in the employment of boys in lieu of men.

Fire Office Rules.

WE are all agreed that there should be a standard set of fire rules for electric lighting, but while electricians, like doctors, disagree, we seem as far off this desirable end as ever. Professor Silvanus Thompson lauds Mr. Heaphy and the Phœnix rules to the skies, and suggests their general adoption on the grounds that they have stood the test of time and are workable. Mr. Verity and Mr. Campbell Swinton, both men of practical experience in the wiring and fitting of houses, a matter in which Professor Thompson cannot claim a like advantage, hold the opposite view with very good reason, as a perusal of their letters to the *Times* will show. We agree with these gentlemen so far as their objections to the Phœnix rules are concerned, although we consider that the Institution of Electrical Engineers need not be concerned in the question at all. The desired result should not be difficult to arrive at by a judicious combination of supply companies, contractors, and fire offices, and we shall probably refer to this important topic more lengthily in a future issue.

ELECTRIC RAILWAYS AND OCEAN CABLES.*

By T. D. LOCKWOOD.

I HAVE read with a good deal of interest the communication of Mr. Cuttriss, in *The Electrical Engineer* of August 6th, concerning the disturbances manifested in his cable-receiving instruments, which he attributes to the operation of an electric street railway, at a distance of upwards of half a mile therefrom ; and with equal interest the editorial comment on said article.

Though it is doubtless often unpleasant to be like Mr. Cuttriss and myself on the physically weaker side of a controversy, that position is not without its offsetting advantages, in that we are forced to study, and let us hope sometimes to master, the problems they involve ; while persons working with less delicate appliances and with the electrical pursuits which cause, as distinguished from those which suffer from, the disturbances, are often and naturally content with a perfunctory examination of the matter.

As I have read the two articles, I gather that the disturbed cable circuit comes into the station from the sea conductor, passes through the instruments at the said station and then back by way of a closely parallel insulated conductor in the same cable to earth at the cable armour.

If I have correctly interpreted the arrangement, it is first to be observed that it is not as stated in the editorial comment "a complete metallic circuit," but simply a loop of an earth completed circuit, the two wires of said loop being parallel.

I should scarcely expect that any such disturbances as are described arise from magnetic induction, and in the light of experience do not believe they do, not so much, however, because the wires are looped for a certain distance, as from the fact that in addition to said looping, they are buried ; they are underground ; both conditions would tend I think to adversely affect magnetic induction.

I am inclined to believe that the disturbances have a twofold cause ; that they are partly due, as Mr. Cuttriss suggests, to actual conduction through the intervening earth and water from the earth side of the electric railway circuit to the cable armour, and thence by way of that conductor, which is grounded on the armour, and through the instruments to the cable main conductor ; and also in part attributable to the actions and reactions of electrostatic induction, which in such a case are likely to be complicated.

We may consider the earth, if of favourable constitution, to be heavily charged by the electricity poured into it from the cars.

It is not difficult to conceive that such a charge in the medium surrounding the buried cable will tend to attract a like charge of opposing sign, through the dielectric on both conductors of the cable. Thus if the earth be charged to a given plus potential by the railway, the two parallel conductors of the cable loop will both be the recipients of a minus charge. But this charge must come from somewhere, and as the armour earth terminal is nearer than any other, the major part of it comes from that point. But there is another reaction ; the two sides of the loop are of unequal length, and it may well be imagined that the charge on the short side, that grounded on the cable armour is thicker, if I may so express it, than is that on the long leg which is but the end of the main cable conductor. The two will tend to react on each other, and the amount of the perceptible reaction will be the difference of the two charges.

But of course, any change in the potential or degree of charge in the surrounding earth, will eventuate in a redistribution, and a rearrangement of the charge in the cable ; and such a rearrangement amounts virtually to a circulation of current. And as all changes or transfers of electricity from one side of the loop to the other must pass through the instrument, we necessarily have the undesired operation of the said instrument.

The editorial says : "There will, of course, be a solution for the difficulty, but it will be interesting to see just what it is." The solution of the difficulty is, in my opinion simply the use by either party of the complete parallel wire metallic circuit, imperfectly and at a high cost, by the cable company, whose property is trespassed upon ; or in a practically perfect way, at a comparatively low cost, by the railway company, who is doing the trespassing.

* See last week's ELECTRICAL REVIEW.

ELECTRICAL SIGNALLING APPARATUS.

IN presenting the report of the Comité des Arts Economiques upon the results of the competition established in 1884, by the Société d' Encouragement pour l' Industrie Nationale, relative to the invention of an apparatus for announcing the passing at a distant point of railway trains, M. Rouselle said the result of the competition had been the bringing to light of several interesting devices, but no definite decision had been arrived at, although the time for fulfilling the conditions had been ultimately extended to 1889 ; the value of the prize had also been raised from 2,000 to 3,000 frs. The several prorogations which had taken place had been necessary, in order to allow of the exhibits being properly tested by actual practice. The competitors numbered fifty, and many new and ingenious ideas had been put forth, notwithstanding which, only two of the competitors, viz., Messrs. Baillehache and Clémandot, the latter a member of the Societé, had been able to establish their claims, M. Baillehache's device consisting of an insulated counter-rail, placed at the point from which the train in movement starts the signal, and in connecting by a wire this counter-rail to the station at which the signal is received, and which is furnished with a battery and an alarm. The springs of a passing train establish a connection between the two rails, and a circuit is formed, which, having traversed the wire connecting the two posts, returns to the earth and is closed by the springs. The alarm is sounded, and not only announces the presence of the train, but also its speed and the number of carriages composing it. A very useful, and even necessary complement of the system, is a controlling wire, by which the circuit is closed when the commutator button at the receiving post is pressed. By this the agent is in a position to satisfy himself that the apparatus is in working order.

M. Clémandot's system, which possesses the important advantage of dispensing with any moveable accessories in establishing the circuit, is based upon the difference between the electric resistances of two lines of rail, according as they are united by the wheels and springs of the train, or they are free. At the signalling point, a battery and an electromagnet are placed at the sides of the line ; at the receiving station a relay is established by means of another battery and magnet and an alarm is established in derivation. Two wires form the connection between the two stations. Under ordinary conditions, a continuous current traverses the whole extent of the circuit. When a train is passing the armatures of the electromagnets are displaced, and the normal current is replaced by two local currents, one of which, at the signalling station, is closed by the springs of the train, whilst the other, at the receiving station, traverses the alarm in derivation and sets it going.

Notwithstanding the thorough testing over a period of several years, on various railway lines, which these apparatus have undergone, the committee remains undecided. Both systems, in fact, have been impeached as open to serious objection, sometimes on the score of safety. The committee, however, expresses the hope that so much skill, ingenuity, and knowledge on the part of the inventors will not have been expended in vain. The Society is unable to award the prize to either, but a distribution has been made as a recognition, to some extent, of the value which attaches to their labours.

M. Baillehache will, accordingly, be awarded 1,000, and M. Clémandot 1,500 frs., as it is considered that the latter's system affords the better guarantee of safety, a consideration which the committee judges to be of supreme importance.

HIGH POTENTIAL STORAGE BATTERIES.

IN one of his early patents, Mr. Faure describes a method of arranging lead plates in such a manner that connectors and separate receptacles can be dispensed with. Plain sheet lead, pasted on both sides with red lead, is packed between elastic frames, constituting three sides of a cell open at the top. The space thus produced between the plates is filled with the electrolyte, the first and last electrode of a series of such cells being then connected to the source of supply. With the exception of the end plates, each intermediate electrode will become negative on one side and positive on the other. The capacity (in ampére hours) of such an accumulator is necessarily limited to the dimensions of one plate, and the electromotive force is proportional to the number of plates. A similar battery has recently been invented in New York, called the "Dey Series High Potential Storage Battery." Mr. Dey uses a hard Indiarubber case made of sheets which are screwed together. This is lined with a soft rubber box having ribs running down the sides and across the bottom. The lead plates, which have a raised rim, slide down the grooves formed by these ribs, and when the side is screwed on it forms watertight joints between the ribs and plates. The plates are made grid fashion, with a web or partition down the centre and projecting half-an-inch above the active material to keep the acid separated. The active material is applied in the form of a dry powder, red lead being placed on the positive side and litharge on the negative. The plates are 9 inches by 15 inches by $\frac{7}{16}$ths thick, placed $\frac{3}{4}$ths inch apart. A complete cell containing eleven whole plates and two half or end plates, has a normal output of 94 ampére hours, and an E.M.F. of 24 volts, and it weighs 210 pounds. This does not show any advantage over existing types with separate cells, which are preferable for various reasons. Mr. Dey has a novel arrangement for cutting out of circuit the battery when fully charged, somewhat, we think, on the lines of an apparatus used in the old Colchester installation. This cut-out consists of an inverted U-shaped tube which is filled with acid and suspended on the plate. The gas from a fully charged cell rises into the tube, displaces the acid and thus causes the tube to move upwards against a spring making contact with the apparatus which operates the cut-out. The Sawyer-Man Electric Company use two series of six cells in their photometer room, giving an E.M.F. of 144 volts. Plates of this description will necessarily buckle, as the positive side alone expands. Concerning this defect, Mr. Dey maintains, "that when they do buckle (which occurs rarely) they all buckle in one direction (positive side out) and fit into one another like saucers." It must be an interesting sight after, say, a year's continuous work, if the arrangement can hold out so long.

THE RELATIVE POSITION OF GAS AND ELECTRIC LIGHTING.

IT may perhaps be interesting if we refer to the relative present position of gas and electric lighting, and in order to do this we must review the status of the two illuminants during the past three years. In 1887, 1888, and during the first half of last year, gas companies, and the supporters of the older light regarded with indifference the gradual increase in the use of the electric light, and the consensus of opinion arrived at by them was that there was not the slightest fear that electricity for illumination purposes would be a formidable competitor of gas. Statements to this effect were frequently made at the meetings of the gas companies, and the shareholders were assured that the possibility of the use of the electric light acting detrimentally to their undertakings was entirely out of the question. As time passed away there came into existence numerous companies for lighting by electricity the most remunerative—to gas companies—London districts and provincial towns. In some instances the gas companies opposed the applications made by electric light companies for Parliamentary powers, but their opposition was unsuccessful. Such was the state of affairs some time ago.

At present, however, the position is entirely changed. The inauguration of new central electric light stations, and the erection of others throughout the country, have caused some gas companies to recognise the fact that the electric light is not only a competitor, but that it is also gradually superseding gas in many large establishments, which were formerly considered among the most profitable customers to the gas companies. To show to what extent this condition now prevails, we may mention that in the metropolis alone the two largest companies—the Gas Light and Coke and the South Metropolitan—have sold considerably less gas during the half-year ended June 30th than in the corresponding half of last year. The amount of the dividends paid has also diminished, that of the former company being 13 per cent., as compared with $13\frac{3}{4}$ in the corresponding half of 1889, and that of the latter being 12 per cent., as against $13\frac{1}{2}$. Moreover, the Gas Light and Coke Company found it necessary some time ago to increase the price of gas by 3d. per thousand. In these two instances the diminution in the consumption is, of course, not considered by the companies concerned to be due to the competition of the electric light; but it is significant that they are seeking new openings for the use of gas—a fact which leads to the conclusion that the two companies are fully aware that in certain districts they cannot possibly expect to increase the sale of gas for lighting purposes, and that the diminution already taken place must to a certain extent be attributed to the gradual adoption of the electric light by those who are prepared to pay for it. Again, the directors of provincial gas companies no longer consider their position impregnable, and they are therefore following the example of the London companies by endeavouring to extend the uses of gas, and at the same time keeping a watchful eye on the progress of the "coming" light.

It may appear surprising that the shareholders in gas undertakings should take the trouble to ascertain the position of the electric lighting industry; yet such is the case. We know of instances where the holders of gas stocks have asked financial journals, representing the gas industry, to explain the present position of the electric lighting business in so far as it related to the supply of gas, in order that they might decide whether to increase their shares or otherwise. Actions of this kind distinctly indicate the feeling of distrust on the part of some gas shareholders, for although in some instances where the electric light has been introduced the consumption of gas has augmented owing to its being used for other than lighting purposes, yet in others the reverse has been the result.

It would appear from this that the use of gas for lighting is slightly diminishing, but that for cooking and heating and motive power purposes it is increasing. It is therefore in these directions that gas companies will be able to augment the consumption, and to these three branches great attention is being devoted. The days of the "no competition" theory have passed away, and it is satisfactory to find that many gas companies realise the important fact that, notwithstanding its higher price, many consumers prefer to have the electric light.

English Lighting Companies Note.—The Continental Edison Company, which has a nominal capital of £400,000, actually supplied current during July in Paris to the extent of £3,220 gross.

COMPRESSED AIR FOR THE TRANSMISSION OF POWER.

THE transmission of motive power by means of compressed air on the "Popp" system—an ominous name for English ears—is exciting some attention in Germany where efforts are being made to represent it as equal, if not superior, to the electric transmission of power. The report of Prof. Gusinde in favour of electricity, is being criticised by officials of the Berlin Compressed Air Company, and the respective assertions of these rivals are given by the Berlin *Finanzherald*, which seems to have a manifest leaning to M. Popp and his scheme.

As a specimen of the style in which this controversy is being waged, we may quote the following passage from Prof. Gusinde's report, followed by the reply of the Poppers. Says Dr. Gusinde—we believe with full truth: "In America, where numerous electrical central stations are at work, the compressed air system has nowhere found admission, whilst the electrical transmission of power has been for a long time introduced for all trade purposes and is continually growing in extent and importance. It may be here mentioned what prominence the electromotor has obtained in America in tramlines, whilst the air motor cannot undertake a competition in this promising region."

If this is true, it is an important piece of evidence against compressed air transmission. If it is not true, it is the duty of the Popp Company to show *when* and *where* air tramlines have been in successful operation, and what, if any, are their advantages over electric lines.

Instead of so doing, the Popp Company merely reply: "Tramlines with air-propulsion have been at work for some time." Where, and with what result, the reader is left to guess. They add: "It is therefore the duty of a serious critic to take the results of these air-tramlines into consideration." Surely, it is rather the duty of the Popp Company to adduce—if they can—any facts calculated to refute the statements of Prof. Gusinde.

Again, said the latter *savant* in his report: "The superiority of the electrical transmission of power is hence demonstrated." The reply is, "that the superiority of the electric transmission of power is not proved!" Here the Popp Company ought to have shown, or tried to show, some superiority on their side. But no attempt of the kind is made. Surely a different style of advocacy is needed to secure a favourable verdict from an educated public!

WHAT CONSTITUTES A DANGEROUS ELECTRICAL CURRENT?*

By NELSON W. PERRY, E.M.

PART I.

THE question is continually arising as to what is a dangerous current of electricity, and the answers that may be encountered are usually so varied that the enquirer is prone to ask again with the result as unsatisfactory as before, and a conclusion that the electric fluid is as mysterious in its effects upon life as it is to most people in its other manifestations.

It would not be far wrong to state that the most general feeling in regard to this question at the present time is that a given current might kill to-day and be harmless to-morrow; that what would be certain destruction of life to one individual could be safely borne by another. In fact, such a belief is but a consequence of that very common opinion among the laity that electricity is not amenable to infallible laws like other forces, or that if it is, then such laws are at present but imperfectly understood.

Such, however, is far from being the truth. It is indeed very common to hear the statement that we do not know what electricity is—but how often do we hear the statement that we do not know what gravity is?

How many of us if asked the question would hesitate for a moment in stating that we were in possession of full knowledge in regard to gravity and yet at the same time would delegate electricity to the unknown, and perhaps to the unknowable? And yet of the two, much more is actually known to-day about electricity than is known about gravity. In fact, the electro-magnetic theory of light so beautifully formulated by Clerk Maxwell has received at the hands of Prof. Hertz within the past two years, experimental demonstration, and we know beyond peradventure that electricity is a phenomenon of the ether in the same sense as light is.

We cannot say that we know all the laws of light—we know a great many of them—in fact, nearly all that are necessary to explain the phenomena with which we are confronted, and we find that these laws are all absolute in their workings—they are infallible.

So it is with electricity. If we do not yet know quite what it is, we are certainly much nearer a solution than we are in the case of gravity. It would be folly to say that we know *all* the laws of electrical action, but we probably know even more of its laws than we do those of light, and they are in no way less certain. In fact scientists have long since come to the conclusion that the laws of nature are all infallible. It is a fundamental doctrine of science that under like conditions like results must inevitably follow. There are no miracles in science; there may be mysteries, but they are mysteries because of our ignorance of the conditions, and not because of the abeyance of any of nature's laws. The difference between the scientific mind and the unscientific mind is that if an apparent contradiction of an accepted law is noted, the former assumes some condition not understood, and the latter immediately assumes it to be what it appears, viz.: A direct contradiction of the law.

To the latter such a thing is not so very remarkable—the world is full of just such contradictions; it is therefore not inconsistent with previous experience, and it does not even excite surprise. To the scientific mind, however, such a thing as the fracture of a law or its abeyance for one instant is an utter impossibility and unthinkable.

Electrical science to the unscientific mind may logically be a department of contradictions; but to the electrician it is one of fixed and inviolable laws as are all the other sciences; and what is more it has arrived at a position of an exact science in which results can be predicated from given data with mathematical exactitude and precision. In fact astronomy does not rest upon a more sure mathematical basis than does the science of electricity.

Electricians are sometimes asked to explain many things that never occurred; for instance, it is universally acknowledged that 110 volts—that usually employed in the incandescent light is perfectly safe as far as life is concerned. Yet not long ago it was announced all over the country that a little coloured boy was killed at Chattanooga by coming in contact with an incandescent light wire of 110 volts, and electricians were asked to explain how this could happen. It could not be explained, and was not until the coroner's inquiry developed the fact that no electricity had been on the wire for over a half an hour previous to the boy's coming in proximity to it, that the boy did not die from an electric shock, and that the burns that were attributed to the electric current were due from an oil lamp which the boy had in his hands, and not to the electric current.

And then supposing the statement were true, and it is not questioned anywhere, that a current of 110 volts such as is usually employed in incandescent lighting is perfectly safe, yet it is not true that it is safe to touch every incandescent circuit one meets. Most of our electric street cars are operated by a current of 500 volts pressure. In all such you will observe five electric lights, similar to those you see in the stores. Now while each

* *Western Electrician.*

of these lights is only called upon to stand a pressure of about 100 volts, they are placed in a row or in "series," so that the same current passes through each in succession, and meets with the combined resistances of all of them. In such a circuit five lights of 100 ohms each resistance can be opposed to a pressure of 500 volts, and yet the effect would be to subject each individual light to a pressure of one-fifth the amount, or 100 volts. One can, however, take his choice of shocks due to 500, 400, 300, 200, and 100 volts, according as he short-circuits five, four, three, two lamps, or only one.

In case an electric road were operated by a current at 1,000 volts, it is evident that ten 100-volt lights could be operated in series in each car, and under these circumstances the seeker after sensations could get anything he wanted in the way of shocks from that due to 100 volts pressure up to that due to 1,000 volts pressure. That it is quite evident that while the first statement might be perfectly true if comprehensively understood, yet it would not be advisable to assume that all incandescent light circuits, or even all circuits containing 110-volt incandescent lights were safe. And again, as we have seen that in the 1,000-volt circuit all pressures from 100 volts to 1,000 could be obtained according to the point where one touched the wire, so it would not be safe to assume that because I touched the circuit with impunity at one point you or anybody else could do the same at another point. And yet this is just what would be assumed by the majority of people, and if you were killed, and I was scarcely shocked, it would be referred to as an illustration of the idiosyncrasies of the electric current.

A couple of summers ago I was present at the starting of a new electric underground railroad in one of the coal mines in Pennsylvania. The trolley wire—to use an Irish bull—was a light T-rail, supported on timbers overhead out of reach of persons standing on the ground. At one point there was a switch by which the current could be turned on or off, and on this day, as it was desirable to have this readily accessible, a large wooden block was placed on the ground underneath it. By standing on this, one could readily reach the trolley rail and switch. Had the block been a perfect insulator, a person standing upon it could have touched the trolley rail without the slightest shock, even though there had been 5,000 volts instead of 350, as was the case; but as it was, the conductivity was just sufficient to give one standing upon it, and touching the rail, a right smart shock, and the whole thing being new to the miners, they were amusing themselves by getting up and touching the rail.

One man, thinking to have a little fun at the expense of another, jumped upon the block, and while he touched the rail with one hand, grasped his intended victim, who was standing on the damp ground, with the other.

He thought to surprise his friend with a slight shock, such as he himself had been taking in fun before, but the joke was a huger one than he had anticipated, for, by grasping the other man's hand, he made a good connection with the ground, through his own as well as his friend's body, and the result was that both men were violently thrown to the ground, and so quickly, that they scarcely knew what had done it; neither man was hurt, but all had a great respect for that trolley rail thereafter.

Not many days from this time, a mule came in contact with this same trolley rail, and was almost instantly killed, and in falling he pulled his mate over in contact with it, and he, too, was killed. Now here were three different effects from the same current, yet the conditions being different, the results varied widely.

Now, if we were to try to reason by analogy, we should say—this current was strong enough to kill two mules, therefore these two men ought in all fairness to have been killed. But they weren't.

Again, among the miners it was argued that since one man alone on the block could easily stand the shock, and two men catching hold of hands were both thrown to the ground, if three or more had hold of each other, they certainly would have been killed.

The electrician readily sees the fallacy in the last argument, but he does not see how the mules should have been killed while the men escaped. He merely knows from numerous instances, of which this was one of the first recorded, that mules and horses are very much more susceptible to electrical influences than is man. Why, he does not pretend to say any more than he does why a pig will fatten on arsenic or antimony which are fatal in small doses to man. The physician can tell, perhaps, but not the electrician, and the physician had to learn the fact from experience; there was not *a priori* reason why it it should be so.

This calls to mind an amusing story that I once heard as to the origin of the term "Antimony," which is the name of a metal closely resembling arsenic in many of its properties.

Some monks had found a new mineral and had prepared from it a new metal, which, so far as they could see, proved to be utterly worthless, so they threw it away. It fell within reach of some of the hogs belonging to the monastery, and the monks noticed that they devoured it with apparent relish. Curious to know the effect of such a diet upon the swine, they fed them regular with it for some time and found that they not only prospered, but grew enormously fat upon it. Some of the monks reasoned that if it was so good for the hogs it ought to be good for themselves too, so some of them partook of a liberal dose of it, resulting in their speedy horrible death by poisoning. The new metal was therefore called "Anti-Moine," which by slight change has become Anti-mony.

The authenticity of this origin for the term is very seriously doubted, but the story serves to illustrate that the fact that 350 volts is fatal to a mule while it is not to man, rests upon the same experimental data that the other fact does—viz., that a hog can eat some things with profit that are not conducive to longevity in man.

Now, while I know of no *a priori* reasons why a certain quantity of electricity should be fatal to man, still I believe it to be an established fact that the quantity that will be immediately fatal can be fixed with as much certainty as can the fatal dose of any of our well-known poisons, and I think it is now surely settled that a single ampère of current caused to pass through the vital part of the body is much more certain to be instantly fatal in all cases, and, in any case, than is hanging by the neck; and I think the question "is hanging necessarily fatal?" much more doubtful than is the other one—"is one ampère of electricity necessarily a fatal dose?" and the answer to both of them is "Yes, if properly applied."

A man may be hung by the neck without breaking it, or he may be hung by the hand or by the waist, and if not kept suspended too long, there will be little danger of death. So may a man take one or several ampères of current through the hand or leg or foot, or other non-vital portion of the body, and be not permanently disabled, but I do not believe that it is possible for him to take one ampère in such a way that the brain or the heart are in the direct line of the current without instantaneous and painless dissolution.

It has for a long time been generally admitted that one ampère of current, if properly applied, was considerably in excess of that required to produce instant death in man—there has practically been no question as to that, but the question has been how great a voltage was necessary to ensure the passage of an ampère of current through the body. It has been supposed, and there has been much testimony adduced in support of the supposed fact that the resistance of the human body, and therefore the electromotive force necessary to drive a given quantity of electricity through it, was such a varying and variable quantity that measurements made of the resistance of certain individuals at one time were of absolutely no value in the case of other people, or even in case of the same people at a different time. In fact, there seemed to be some ground for believing that the human body offered very different resistances to currents of different potentials, and if this were so, a determination of the resistance to the milder currents, that could be used without disagreeable con-

sequences, would be of absolutely no value in arriving at the resistance that would be opposed to currents of higher pressure.

The importance of knowing the resistance of the human body at the time of experiment is essential in arriving at either the number of ampères that a given electromotive force will drive through it, or the number of volts that are necessary to force a given number of ampères through it.

As late as last summer, there was nothing but the most contradictory evidence on this all important point, if we are to take the evidence of electrical and medical experts who appeared before referee Becker in the Kemmler appeal.

One expert found, upon testing the resistance of a certain electrician, these results :

With a current of	1	volt	the resistance was	6,300 ohms.
„	„	10 volts	„	5,140 „
„	„	50 „	„	3,850 „
„	„	100 „	„	3,500 „

The current was passed from one hand, through the body, to the other hand, perfect electrical connection being provided for by moistening the hands with a solution of sulphate of zinc. These experiments seemed to indicate that as the electromotive force increased, the resistance of the body decreased.

Next a newspaper man was tried. Connection was again made by means of a solution of sulphate of zinc, but in this case the current was passed from the head to the feet. As was perhaps to be expected from the subject, the average resistance was much greater.

In the	first	experiment	it proved to be	7,097 ohms.
„	second	„	„	6,297 „
„	third	„	„	6,092 „

Newspaper men are proverbially early risers, but the electrician is not to be outdone if he knows himself, so the next witness to testify was an electrician who had tested his own resistance from hand to hand with the following results.

Using the current from one cell, his resistance was 80,000 ohms.

Using the current from 10 cells his resistance was 37,000 ohms.

Later, using the current from one cell, his resistance was 31,000 ohms.

Later, using the current from 10 cells, his resistance was 24,500.

Two minutes after using the current from one cell, his resistance was 36,000 ohms. Using the current from 10 cells, his resistance was 21,500 ohms, and in the final tests with one cell, he found his resistance to be 21,600 ohms ; with 10 cells he found his resistance to be 16,000 ohms.

These figures seemed to show two things—first, that, as the electromotive force experimented with increased, the resistance of the body decreased ; and, second, that, in a series of experiments following each other in rapid succession, the resistance very rapidly decreased.

The significance of these figures is apparent when we remember that, in order that one ampère of current shall be forced through a resistance, the electromotive force, measured in volts, must exactly equal the resistance, measured in ohms.

Thus, from the preceding testimony, we find a variation in resistance from a maximum of 80,000 ohms, which would require an electromotive force of 80,000 volts, if one ampère is the current required, down to a minimum of 3,500 ohms, through which it would require a pressure of 3,500 volts to force the same current—a variation between maximum and minimum of nearly 2,300 per cent., and in the case of the same individual, at different times and different potentials, a variation from 80,000 to 16,000 ohms, or 500 per cent.

It is evident, if these figures are reliable, no value whatever is to be attached to measurements made at one time in determining what the resistance would be at another.

It was known that the skin offered the greatest resistance to the passage of the current, and it was readily surmised that in different individuals greater or less callousness might be responsible for very great variations, and in the case of the same individual it was readily to be conceived that the difference in the condition of the skin as regards moisture might have a controlling effect in the measurement of the resistance of the body, and a moistening of the hands with a solution of sulphate of zinc—a good conductor of electricity—was resorted to in the first two cases cited, to remove this difficulty as far as possible, and to insure better contact. But zinc sulphate is a powerful astringent, and has a tendency to harden the epidermis and prevent its absorption of moisture, or its exudation in the form of perspiration, and, as might have been foreseen, failed to accomplish the object for which it was intended.

Thomas Edison had foreseen the objection to the use of sulphate of zinc, and also another, viz., that it would be totally impotent to remove the insulating effects of of the oily exudations of the skin, and in other respects, since the resistance would depend very much on the tightness with which the electrodes were grasped by the person, it would be very difficult to obtain the same conditions with two different persons, or to maintain them the same with the same individual during two successive experiments.

So in his experiments to settle the question in his own mind as to the resistance of the human body he chose a liquid for moistening the skin that was not only not an astringent, but rather the reverse, and which at the same time was detersive and would saponify the grease.

In a solution of caustic potash he found just such a fluid, and he eliminated the uncertainty due to the variability of pressure upon the electrode by causing his subjects to place themselves within the circuit by immersing each hand in a metal jar of this solution which was connected electrically with his battery.

Following this method, by which he sought to maintain his conditions more uniform, he tested the resistance of 250 subjects—probably by far the largest number that has ever been tested under even approximately similar conditions, and found *their average resistance* to be 1,000 ohms, and out of all this number the extremes were 1,800 and 600 ohms.

He also found that the resistance of the same people at different times was practically constant—the maximum variation of the same individual at different times was 50 ohms, or 5 per cent. of the average resistance.

Thus we see order again brought out of chaos.

The experiments have since been repeated, though not on the same scale, with results so concordant that it is now considered a pretty well settled fact that the human body does not vary more widely in its behaviour toward electricity than it does toward other things—drugs or poisons for instance, and the normal resistance of an adult body is a pretty well-fixed figure, and the maximum variation from the figure as determined for the individual does not exceed 5 per cent. under ordinary conditions.

ELECTRICITY IS LIFE.

IT is said, although we confess that we have not yet experienced the sensation, that before a thunderstorm everything has been so still for days that the oxygen in the air has been to some extent deprived of its life-sustaining power, and a feeling of drowsiness comes over all. The air has been partially devitalised, and is not fit to produce in man to the same degree the usual vitalising effects. But the lightning flashes restore the lost energy to the oxygen, and a feeling of exhilaration is experienced after the thunderstorm is over. "What the electric flashes effected in the devitalised air of the chamber in which the experiments on the animals were made, the lightning effects in the weakened air during sultry close weather ; vitalising power is restored to it." The quotation is taken from a contemporary, in which certain experiments on animal life are described as

follows:—"After several animals had been breathing in a chamber of pure oxygen, Dr. B. W. Richardson collected the gas in the chamber and freed it from all but the oxygen, so that no chemical test was able to show any difference between its character and composition and those of freshly-made oxygen gas. When he passed this purified oxygen for the second time into the chamber, the animals soon became drowsy, and on repeating the experiment by successive purifications of the exhaled air the animals died. He concluded, then, that oxygen which had been repeatedly passed through the lungs of warm-blooded animals, however thoroughly purified from carbonic acid, watery vapour, and ammonia, no longer maintains life. It has become what is scientifically called "devitalised." But the startling discovery still remains. He passed through the devitalised oxygen currents of electricity from a set of brushes connected with the positive pole of a frictional machine, and the gas had its vital energy restored; animals again lived in it with the customary sprightliness. He discovered that electricity restores to its vital state oxygen which has been rendered noxious by passing through the lungs of animals."

We are not aware whether these experiments are of recent date or not, but they are sufficiently remarkable to lead to the hope that the subject may be pursued further, for they appear to have a direct bearing upon our vitality, and suggest uses in domestic life for the frictional machine such as have not yet been heard of.

Equally suggestive are the results of applying electrical treatment to milk which, as is well known, tends to grow acid during thunderstorms. An Italian, Professor G. Tolomei, has lately tried to throw some light on the nature of this action. He experimented with electricity on fresh milk in three different ways—first, by passing the discharge of a Holtz machine between two balls of platinum inserted nearly two inches apart in a bottle containing milk; second, by sending a battery current between two strips of platinum at the bottom of a U tube holding milk; and, third, by subjecting milk in a test tube to the action of a strong battery current through a silk-covered copper wire wound spirally round the tube. In each case the acidulation was delayed, not hastened. Three equal portions of milk from the same milking, thus treated, began to grow acid on the seventh, the ninth, and the sixth day respectively, while milk not treated with electricity was manifestly acid on the third day. The electrified milk (unlike milk that has been heated to a high temperature, then cooled), coagulates naturally, or by action of rennet, just like ordinary milk. Having thus seen that electricity could not be the direct cause of acidification of milk, the professor next tried the effect of ozone, and found it distinctly acidifying. In one case the surface of a quantity of milk was brought close under the two balls of a Holtz machine, and the milk soon became acid in consequence, the sooner if the discharge was silent (not explosive), in which case more ozone is formed. In another case ozonised oxygen was made to bubble up through a quantity of milk, which in a few hours was completely acid and soon coagulated spontaneously. Professor Tolomei is of opinion that oxygen probably also promotes lactic fermentation (a point which has been disputed). If milk keeps longer in wide, shallow vessels, that is probably due, he thinks, to the cooling produced by evaporation, which is favoured by a wide open surface.

The only thing now required is that the same treatment should be applied to the purification of alcoholic drinks, in which at times people are apt to indulge too freely in the belief that good spirits promote a happy state of being, a judicious mixture of milk and spirituous liquor at early morn being calculated to bring about the desired effect.

Acknowledgment.—Through an oversight, the source from whence we derived the description of Mr. Field's telephone (*Electrical Engineer*, of New York), was not acknowledged in the article last week; we hasten to express our regret.

ELECTRIC TRACTION DATA.

AMONG the first and most exhaustive power tests with electric cars were those made by Mr. A. Reckenzaun some three years ago in the City of Philadelphia, and they were published recently in a paper bearing the title of the present article. No less than three well trained men were required for the purpose of making observations, and recording them. Thus, on one occasion, during a run of 43 miles, 7,500 ammeter readings were taken, which had to be written down at the rate of 20 per minute. Considering the very rapid variations of the currents used on uneven tracks, it is absolutely necessary that readings should be recorded in the shortest possible intervals, so that a correct average may be estimated. This process is extremely tedious, and liable to error, in spite of the greatest care of a skilled hand and eye, and many have been the attempts to devise an apparatus which should automatically record the power consumed on an electrically propelled vehicle. The jolting of a car has very little effect upon the extremely light needle of a dead beat ammeter; but the introduction of a pen or pencil must produce deviations due to the momentum of such moving parts of the instrument.

The *Electrical World* of the 16th inst. contains a description of a recording ammeter devised by Messrs. Hulett and Larned, which has been used in recent tests on the Thomson-Houston road at Syracuse, N.Y. This instrument is not free from the objections we have mentioned, yet it appears to have answered its purpose to a sufficient extent to give very approximate values. This apparatus consists essentially of a solenoid 7 inches in diameter, containing 80 turns of copper cable, through which the maximum current of 150 ampères may be safely used. The solenoid is fixed vertically upon a board, and it contains a movable iron core $1\frac{1}{4}$ inches in diameter, which carries a pen at its upper end. This pen presses against a strip of paper upon a drum, which rotates by means of clock work. The magnetic attraction exercised by the solenoid upon the iron core is balanced by a spring, whose tension is so regulated that a pull of 10 lbs. will produce a deflection of 3 inches; the object in providing so great a force was to render negligible the friction of the core against the bobbin, and of the pen upon the paper and vertical guides. The circumference of the paper drum is 24 inches, and it rotates once an hour; the space allotted to record the variations is 2 inches for every five minutes, and this was scarcely sufficient, the vertical pen strokes due to the current changes coming in some cases too close to each other to render them distinguishable.

In order to obtain the mean ordinate for a whole day, it was necessary to integrate with a planimeter the space included between the curve and the zero line; thus the area was found which, divided by the length, gave the mean height of the diagram. As the movements of a core within a solenoid are not proportional to the current, the instrument was integrated in three parts, and each portion read separately from the calibration curve. The results thus obtained were considered to give a very close approximation to the truth. The object of these tests was to obtain (1) the efficiency of the station, (2) the efficiency of the line, (3) the efficiency of the cars. Ammeter and voltmeter readings were made every 25 minutes at the same time, while indicator cards were taken from the engines. The efficiency of the station gave an average of 62·8 per cent., *i.e.*, the ratio between the electrical H.P. and the indicated H.P. The highest efficiency observed was 82 per cent. when the I.H.P. was 108; but when the I.H.P. dropped to 30 or below, the resultant efficiency did not exceed 40 per cent. The efficiency of the line was calculated from voltmeter readings taken at the station and line simultaneously, and averaged 91 per cent. Seven cars were on the road during these experiments.

The mean efficiency of the cars (motors and gearing) was calculated from observations at various speeds,

and found to be 65 per cent. The efficiency of the entire system, therefore, from the product of these results, amounted to 62·8 × 91 × 65 = 37 per cent.

The coal consumption has been ascertained to be 4,800 lbs., and since the average I.H.P. throughout the day amounted to 51·4, the coal used came to 5·3 per I.H.P., and 8·4 per E.H.P. per hour. If the plant had been run up to its full capacity, these figures would have been considerably reduced. As the cars ran 98 miles per day, the electrical energy per car mile did not exceed ·82 horse-power hour, and one point incidentally noticed in taking volt readings on the line demonstrated the fact that the curves consumed more power than the grades.

About a year ago, Dr. Louis Bell made some tests on the Sprague road at Lafayette, Ind., and showed that the average efficiency was but 25 per cent., 37 per cent. would thus show a considerable advance in the direction of economy of power. Probably this record will be beaten at no distant date.

THE LIVERPOOL ELECTRIC RAILWAY.

IN a few months there will be opened in Liverpool the overhead railway worked by electricity, which will occupy the proud position of being the first of its kind attempted in England. Last year a few Liverpool merchants met together to discuss the advisability of erecting a railway which would meet the wants of a rapidly-growing traffic. As a result, it was decided to commence the erection of an overhead railway worked entirely by electricity. It was not until the close of the year, however, that operations were fairly commenced. Now the work is being pushed on with great rapidity, and many of the girders are fixed in their places.

The railway, when completed, will consist of a wrought iron viaduct about six-and-a-half miles in length. Columns, composed of two channels and rivetted plates, support the superstructure. Stations are to be placed every half mile, at the points where the population lies thickly, from thence any place on the line will be reached in a few minutes. It is the intention of the company to charge very low fares so that the line may become popular; seeing that it will traverse a working district, this is perhaps necessary, for the revenue will probably be obtained from the lower class fares. The structure will certainly be the finest of its kind, and, as a viaduct, is the longest in the world.

The exact system of electrical propulsion is not yet defined, but there is sufficient guarantee as to the soundness of the technical work when it is mentioned that Sir Douglas Fox and Mr. J. H. Greathead are the engineers.

HIGH SPEED IN ENGINES FOR ELECTRIC LIGHTING.

By ROBERT H. THURSTON, Director of Sibley College,* Cornell University.

JUST a century ago, the "perfected" steam engine of James Watt had fairly conquered its place as a motor and as the great source of power for the growing industries of the world. Although Watt was not "the inventor of the steam engine," as he has been so often and so generally denominated; and although Newcomen and Cawley were its inventors, if we consider the steam engine as a train of mechanism, and not the old eolipile forms, as the germ of the modern machine; Watt, as the great improver and introducer of the engine, deserves all the honour that later generations have accorded him. The invention of the details of the modern engine was sufficient to entitle him to all this, even had the machine done vastly less for the race than it has actually accomplished; but the benefit conferred was largely through the action of secondary and resultant developments. The wonderful expansion of the world's industries during the intervening century has been very largely, if not mainly, due to the provision, by Watt and his contemporaries and successors, of a powerful, convenient, economical and manageable source of power. The most striking phenomenon of the century, to the social and the political economist, has been this enormous development of a thousand new industries, of many thousands of new products of industry, and the extraordinary diversification of the skilled vocations of mankind. All this is to be recognised as consequent, very largely, upon the production by the great inventor of a suitable source of energy and power.

Since the days of Watt, there has been no industrial development even approximately as important as the now familiar and almost matter-of-course introduction and extension of the various applications of the power of steam through the intermediary of the electric current as its strong and far-reaching right arm. The growth of steam engineering during the last decade or more has been almost as great and as wonderful as during the earlier days of the development of the Watt engine. The use of the electric light and of electric power transmission, as in the use of motors and on street railways, and the many minor applications of electricity have compelled the expansion of many old lines of business most remarkably, and have accomplished even more remarkable things in the institution of new kinds of production. The glass-blower has been called upon to produce innumerable new forms, and to resort to numberless new and ingenious processes, to meet the exacting demands of the engineer; the worker in brass and in bronze, in fine iron work and in all departments of light tool-work, has been called upon to modify and to improve his methods, and to invent and apply a thousand new devices to the purposes of this latest of all the departments of engineering.

The maker of wire has been forced to seek the finest and purest copper, and to draw it into wire, harder, stronger, and in greater lengths, than it was ever before supposed possible to secure; new kinds of insulation, new systems of support and of preservation, have come into use, each improvement bringing after it a long train of minor or accessory inventions, discoveries, and improvements. Innumerable new forms of dynamo-electric machines, each specially and precisely adapted to a certain prescribed purpose, generators and motors of once unimagined perfection and efficiency; with, for each one of them, a host of little improvements and inventions in detail, have set the world agog with their work, have made the engineer wonder at their ingenuity, and have puzzled even the man of science and the professional electrician by the delicacy and subtlety of their theory, and by the variety and singular characteristics of their interacting currents and forces.

Finally, the steam engine itself has been given new forms to meet the requirements of this imperative new master. We propose briefly to consider the latest modifications of the engine, giving a concise and untechnical account of its special peculiarities, and the principles of its construction and application, as dictated by the new purposes to which it is sought to apply it.

There are two principal characteristics that distinguish the machinery employed for electrical distribution of energy from most other kinds of apparatus driven by the steam engine. The speed of rotation is unusually high, and the regularity of its motion, to insure satisfactory results, must be made extraordinarily perfect. To these two essentials all other considerations are subsidiary. In the various forms of machinery employed in the arts, outside this department, the first demand of the prime mover is generally economy of operation, and the exactness of its motion is a secondary, though often important, desideratum. In the most exacting work, that of cotton machinery producing fine goods, it has been thought that the regulation of

* *Electrical World.*

the engine driving it should be made sufficiently perfect to keep the fluctuations, with usual variations of loads, within about one per cent. of the mean and within a total range of two per cent.; but, in electric lighting machinery, the range considered allowable is oftener half these figures, and some makers guarantee that the fluctuation shall be imperceptible, from full load to no load. The usual speed of the main line shafting in mills and in shops is rarely above 200 turns per minute, while, in the dynamo, the range is from about 1,000 on those of moderate size and of special types, up to 2,500 and 3,000 in extreme cases; while some are constructed to turn very much faster than the latter, even. The engine demanded of the trade for these latter purposes, therefore, must be capable of regulation to within perhaps one-half the range of the older types, and must be fitted to couple directly to machinery having five or ten times the speed of rotation of ordinary mill machinery. This demand, exacting as it is and seemingly impossible to meet, as it would have been thought not many years ago, has been satisfactorily fulfilled by a number of inventors and constructors.

The difficulties to be encountered in the attempt to comply with such conditions can hardly be realised by those unfamiliar with the steam-engine and its development. It was at once evident that the speed of rotation must be increased, and the ideas of Charles T. Porter, who had, as early as 1860, shown that speed is an element of economy, and had begun to exploit a "high-speed" engine, seeking economy in that manner, were recognised as elements of the new form of engine. In the days of Watt, the speed of rotation had rarely, even with small engines, exceeded 50 revolutions per minute; and Mr. Corliss considered that a speed of 75 revolutions was about as high as his tripping mechanism would ordinarily allow; but Porter went up at once to 200, and the Corliss engine is now sometimes driven at over 100 revolutions per minute. The modern high-speed engine goes far above these figures, however, and 300 revolutions is thought a very fair, but not radical, limit. In a few cases, as in engines of Ericsson and others built for special applications, this speed has risen to as high as 1,000, and even, with very short strokes of piston, experimentally to over 2,000.

Some of the conditions of success in the attempt to solve this great problem are sufficiently evident.* The obviously essential high speed of rotation of such engines can only be attained by simplifying the construction of the machine just as far as practicable, and by discarding the "trip cut-off" and adopting some "positive motion" valve gear. But the trip was considered the vital element in the regulating mechanism of the older engines, as it allowed the governor to do its work without introducing irregularities in its action through resistances coming from the valve motion. Porter adopted a "positive" and then secured good regulation by use of the powerful loaded governor, in the form now so well known by his own name. Hartnell and Guthrie, the inventors of the device in England, and Hoadley, the first to use it in this country, by adopting the now almost universally employed "shaft governor," gave to all later makers the means of solving this problem most satisfactorily, enabling them to use the simplest possible valve gear and yet to obtain a good distribution of steam and the most perfect regulation at the same time—conditions formerly considered absolutely incompatible.

It is practicable to make the "detachable" valve gear operative up to speeds even exceeding 100 revolutions per minute; the shaft governor is adapted to velocities of 200 turns and upward; the higher the better. At 300 revolutions a minute, a common speed with this class of machine, it is possible to regulate, by nice adjustment, to within a range of one-half of one per cent. This has been attained in engines tested by the writer, and may be attained by careful manipulation of the best high-speed engines of almost any well-known makers. This solves the second of the prime requisites—the first from the point of view of application, perhaps—that of exact regulation. No system of electric lighting can be satisfactory in which the fluctuation of speed of engine can be observed at the lamp, in its varying intensity. Such fluctuation cannot be perceived where restricted to a fraction of one per cent., nor can it practically interfere with good work when kept well under two per cent., the once accepted limit.

Economy comes in as a third requirement of the new type of engine. The older "simple" engines were expected to give the horse-power on an expenditure of not more than three pounds of good coal per hour, if non-condensing, and about two pounds if condensing; which corresponded to about twenty-five or seven pounds of steam for the first, and perhaps twenty pounds for the second class, with the best modern boilers, economisers, and heaters. But the older types of engine had a great advantage in their admirable systems of valve gearing which gave an equally excellent steam distribution; the separate steam and exhaust valves, separated ports, and quick cut-off all conspiring to enable the engineer to secure the closest possible approximation to the perfect ideal which is essential to maximum efficiency. The use of a single valve, in the high-speed engine, restricts him very seriously, and compels a certain loss of efficiency. From 30 to 50 per cent. more steam was thus at first used in these engines. Good proportions of valve and of gearing, amply high speed of rotation—itself an element of economy—and practically frictionless and "isochronous" governors were brought out; but the machine still remained a less economical heat engine than the older type, and in most instances, seriously so. The source of this waste and the methods of its prevention were promptly made the subjects of investigation, and the wonderful inventive faculty of the American engineer was set at work to devise improvements.

The cause of waste was very quickly detected in the large amount of "internal condensation" or "cylinder condensation," as it has come to be called, which was consequent upon the high heat-conducting power of the metal of which the cylinder is composed, and the exaggeration of this loss which comes from the increased proportion of surface exposed to weight of steam passed through the engine, as sizes are diminished. The increased speed of engine had diminished its size for a given power, and this had, in turn, with the less effective steam distribution, produced a large percentage of waste. The amount of this loss varies, in ordinary good practice, from about 25 or 30 per cent. in an engine of about 200 I.H.P., to 40 or 50 per cent. with engines of 50 H.P. of the same make, and to 60 or 70 per cent. in engines of from 1 to 5 H.P.* The remedies previously found effective in the prevention of waste were, however, well understood, and were promptly put into practice by the more enterprising builders. These are three in number: 1. Increasing the work of the engine in such manner that the amount of condensation in the unit of time being given, its proportion to the quantity of steam used in the engine in the same time should be reduced. 2. Superheating the steam, thus reducing its capacity for wasting heat in the engine. 3. Compounding the engine so that the waste of the one cylinder might be utilised in supplying the demand due to waste in the succeeding cylinder.

The first of these methods had been found effective, but the new engine was precluded from resort to this expedient from the fact that it was already constructed for as high speed as was found practically safe and satisfactory. The second device was known to be effective; but, while every builder endeavoured to secure dry steam, with more or less success and without meeting with serious embarrassment, the attempt to use superheated steam had been shown, by many years of experience, to be invariably attended with more or less risk to boilers and engine, and with considerably enhanced cost of maintenance. On the

* Stationary Engines for Electric Lighting. By R. H. Thurston. New York: J. Wiley and Sons. 1890. (New edition.)

* *Philosophy of the Compound Engine*; Trans. Am. Society of Mechanical Engineers, 1889; Journal Franklin Institute, December, 1889.

whole, superheating had never become a successful and accepted method of increasing economy, though well known to be in theory and in practice a most efficient means of reducing these internal wastes. A half century of experimental use, under all known conditions, had not given it permanent place among the standard expedients for securing maximum economy of steam and of fuel, even though endorsed by the highest of European authorities, M. Hirn. A few great designers and builders, as Corliss and Leavitt in this country, and Cowper and a few others in Great Britain and on the continent of Europe, had, in special cases—usually in steam pumping engines—made good use of the device; but these instances were rare, and the system was, and is, but slowly gaining ground.

Compounding, on the other hand, had been practiced from the days of Hornblower, the rival of Watt. At first entirely unsucessful, the gradual rise of steam pressures, the gradual increase of the ratio of expansion, and the continually increasing demand for economy in use of fuel and of steam, gave this system a stronger hold as the years went by, and it at last became, a generation ago, a somewhat common method of construction of large engines for important work, and has now become the universal system in marine engineering, and in some departments of stationary engine building, as in pumping engines and the finer class of mill engines of large power. It was not quite understood, however, until recently, by the average practitioner, what were the real causes of its efficiency, and it was not known whether it would pay to employ it in small engines. This last doubt was promptly removed upon trying it, and the "high speed compound engine" is rapidly becoming the standard engine for its special field of work. It was found that the total gain in the best constructions, due to compounding, amounted to something like one-third on engines of large power, and often to one-half with the smaller sizes. This made the difference between success and failure, in many cases, and with a handsome margin on the right side. Nearly all builders promptly took up the system, after the first experimenters had gone ahead.

So far as now known, there are but two ways in which further improvements can be effected. The speed is at a limit beyond which it is expected to go but slowly as methods of construction are improved, and as the attendants become accustomed to management of the new engine; the regulation is as near perfection in the best engines as is either desired or expected; and simplicity of construction can hardly be carried further; indeed, the symptoms are rather that we may see a reaction in the direction of a multi-valve distribution in some cases.

The economical use of steam is still far from that indicated by theory as the ultimate. The engine above referred to demanding from 25 to 70 lbs. of steam per H.P. per hour, as actually built in the various sizes specified, should, if the ideal conditions could be attained, give its power at the rate of less than 18 lbs. The best engines built to-day, of any type and of highest duty, have an ideal expenditure of about 8 or 9 lbs. of steam per H.P. hour, while they actually employ from 13 lbs. upward. The two ways in which these losses, of a third or more, can be further reduced, so far as now known, are increasing the temperature, and, perhaps, the pressure of the steam used, and the production of a non-conducting and non-radiating surface within the cylinder of the engine.

Superheating the steam was shown by Hirn to be the best and most philosophical method, provided it could be made practicable from the constructor's point of view. This has not yet been generally practiced, but it is not improbable that it may be done with good design and construction of the superheating apparatus and proper management of the engine. Its use would render the jacket superfluous, as it is known that the latter has no appreciable effect where the steam is kept dry in the cylinder. No wastes are left that it can affect. It would substitute for the disadvantages of the jacket, as a matter of construction, those of the superheating system. The latter have formerly been the greater; but it does not follow that they will continue to be so. A good superheater, and a good cylinder lubricating system for high temperatures, would accomplish this end. These should certainly be within reach of the inventor and constructor.

The securing of non-conductivity of the internal heat-wasting surfaces of the cylinder would not seem absolutely beyond our reach. A century ago, Smeaton, the greatest engineer of his day, in part accomplished this result by the use of a sheathing of wood on his pistons and cylinder-heads. This cannot be done with the high pressures and temperatures of steam usual to-day; but other plans may prove feasible. Mr. C. E. Emery, many years ago, tried enamelling these surfaces and with enough success to show that the idea is a good one; though the enamels and coverings then available were not suitable for this purpose. The writer has found a method patented by him some time since similarly effective and possibly practicable, and doubtless other inventors will turn their attention to the problem, ultimately with complete success.*

Could a material be found of sufficient strength and a good non-conductor, of which the steam cylinder could be made, this result would be reached, and the efficiency of fluid of the ideal engine would be practically attained.

Like the best engines of other types, the modern high-speed engine now seems to have been brought, in its best forms, to so perfect a condition that the range for further improvement is probably very narrow, and the gain still to be made must come slowly and painfully. In regulation and in simplicity of construction, in speed of rotation and in general adaptation to its special work, it is comparatively satisfactory. The further improvement must be in economy of its operation and maintenance. Greater efficiency of the working fluid will be gained, as in all other heat engines, by increasing the temperature of the steam; higher efficiency of the engine as a machine will follow more effective ways of reducing engine friction; but the compounding of the engine must be taken as the last large economical step in its improvement.

The problems now arising in its application are those which come to the engineer in all departments of his work. He must decide what efficiency he can afford to pay for in increased cost of engine; what size of engine he should adopt for a given amount of work; what size of "unit" of power he may best adopt in dividing up the work, if he is to divide it at all, among several engines, and what each subdivision of power should measure. In general, it is now well understood that the engine should be given a lower ratio of expansion than was formerly supposed economical under specified conditions.† The ratio should rarely, probably, be greater than three or four in simple non-condensing engines, and at less than 100 pounds pressure, or greater than six or seven in simple condensing engines. Compounding enables the engineer to design his engine with a view to expansion down to a terminal pressure—in the latter case of, perhaps, 10 pounds—economically.

The unit of power adopted is made the largest at which the engine can be continuously employed in its regular duties, and for some hours together. Every case, and especially in electric lighting, compels the designer to study the problem from many points of view, and to compute probable expenditures and minima of costs for a variety of possible arrangements,

* My plan consists in dissolving the iron from the surface of the parts exposed to the action of steam, as the faces of the piston, the interior of the heads and the ports, by the use of acid, thus leaving a thin covering of reduced conductivity; which surface is then, if desired, filled with a still better non-conductor, as the resin of a drying oil, with which it may be saturated. The experiments of Prof. R. C. Carpenter and of Mr. P. M. Chamberlain, indicate that this may effect a saving of a large fraction of the now seemingly unavoidable interior wastes.—*Trans. Am. Society of Civil Engineers*, 1890 (*Cresson meeting*).

† For a study of this subject in somewhat wide relations, see papers on "The Several Efficiencies of the Steam Engine," *Trans. Am. Society Mechanical Engineers*, 1882, and *Journal Franklin Inst.*, 1882.

before he can finally safely decide just what system to employ or what type of engine is likely to prove best for the intended establishment and plant. Mr. Field's work at the Edison station in Brooklyn, and that of Mr. Henthorn in Providence, are good examples of this problem, carefully worked out, while the plans of the West End Company in Boston, and many of those produced by Mr. Sprague, illustrate the solution of similar problems in street railway work.

OBITUARY.

SAX, JULIUS, M.S.A., M.I.E.E. Born in 1824, in Sagarre, Russia.—Mr. Sax was educated at Königsburg, and went to Hamburg in the year 1845, where he was apprenticed to the late Mr. Filby, optical instrument maker, of that town. Having served his apprenticeship, he went to Berlin, where he entered the telegraph establishment of Messrs. Siemens and Halske. He came to London in 1851, and worked with Mr. L. Oertling for four years, after which he started in business on his own account for the manufacture of instruments. Mr. Sax was employed by the late Prof. Graham, at that time Master of the Royal Mint, to construct automaton and other balances for use in the Mint. At the Great International Exhibition of 1862 he exhibited bullion and chemical balances, and obtain a prize medal for excellence of workmanship and accuracy. These balances were, on recommendation of Prof. Graham, purchased by the Government for the Mint of Hong-Kong. In 1863 Mr. Sax turned his attention to domestic telegraphy, &c., and in 1864 took out patents for a metallic fire alarm button, which would act as an ordinary call as well as a fire alarm ; also indicators to be used with same and for other purposes. In 1869 Mr. Sax invented a form of magneto A B C telegraph (patented) ; in 1870 an improved mechanical recorder (patented) ; in 1872 an electric billiard marker (patented) ; in 1881 an electro-magnetic telephone (patented) ; an electric water gauge (patented) ; an electric tell-tale clock for watchmen, with a fire indicator combined ; an electric vane ; automatic system of electric call bells for fire stations, &c. (exclusively adopted by the Metropolitan Board of Works for all the stations of the Metropolitan Fire Brigade in London) ; a system of cell calls for police stations, prisons, &c., as prepared for and adopted by the Commissioners of the Metropolitan Police for use at all stations under their control ; also an improved apparatus especially adapted for communicating between drivers and passengers in vehicles, &c. (patented) ; an electric apparatus for checking cash takings (patented) ; a perfected form of automatic fire alarm (patented). Mr. Sax has also made several improvements from time to time in electric bells and appliances for various purposes, and has been awarded eight prize medals for excellence of manufacture, &c. Death took place on the 21st August, 1890, at his residence, 108, Great Russell Street, Bloomsbury, London.

The business of electrical engineer and electric light contractor will be carried on by his sons, at 7, Ridgmount Street, Store Street, W.C.

Pay Station Telephones.—An American contemporary states that a trial of the new automatic recording telephone system is to be had in Brooklyn, N.Y., by the New York and New Jersey Telephone Company. The new device, which is simply on the drop-a-nickel-in-the-slot plan, is to be adopted at pay stations. When a person wishes to telephone at a distance, on ringing up central from the pay station he will be told to place the proper amount in the slot. He will not be connected with the office he wishes to telephone to until he does so.

NOTES.

A New Lamp.—A new all night lamp has been placed before the American public, which contains but one set of carbon holders. The novel feature of the lamp consists in the use of two carbons, held above in a clamp of peculiar design, and a third beneath of special size and shape.

Church Lighting in America.—The first church lighted by electricity in America is a new Catholic church at Westboro.

Investments in Electricity. — It is said that $300,000,000 are invested in electrical undertakings in America.

Variation of Carbon Resistance.—The contribution on page 249, from Mr. Tanner, who sent us such an interesting communication last week, is another example of the truth of the old saw that there is nothing new under the sun. It is clear that Munck showed very conclusively the variability of the resistance of carbon under pressure, a discovery which has been claimed for others of later date.

Okonite.—The New York *Electrical Engineer* of the 20th inst. contains an illustrated description of the Passaic, N.J., factory of the Okonite Company. Water-power is utilised for driving the machinery, but this economical motor will not, we imagine, be available in the English branch works, which are said to be planned after the American establishment, which turns out daily an enormous quantity of insulated wire.

Electric Coal Mining Machinery.—Mr. Foree Bain, of Chicago, has devoted much attention to this subject, and has recently patented a complete system of coal mining by electrically-operated machinery, which consists of an under-cutting machine with an overhead drill for drilling a hole in which to place the explosive charge. The hole is drilled and the under-cut made simultaneously by the same motor. In good coal, Mr. Bain's machine will cut a slot 3 feet wide, 4 inches high, and 6 feet under, within three minutes.

Prison Lighting.—The Western Electric Company has just completed the installation of 1,100 lamps at the House of Correction, Chicago. Not only had the malicious propensities of the prisoners to be provided for, but in dealing with thick walls and steel plates, difficulties in the way of construction were met with to a degree not usual in electric light fitting. The hygienic conditions now obtained are said to have had a marked influence for good upon the spirits of those incarcerated.

Strike in America.—The *employés* of the Westinghouse Electric Company at Pittsburg struck, on August 11th, for shorter hours. 1,200 men are thus thrown out of work.

Fires Caused by Electricity.—A Dalziel cablegram says :—It is stated that the fire losses at Boston, U.S., during the past year have been four times greater than in any year since 1872. To electricity alone is attributed the loss of nearly £200,000 worth of property during the last twelve months.

Electric Drilling Machines.—The Brooklyn Navy Yard has adopted drilling machines worked by electromotors. It is stated that the form is very compact and portable, and a great saving of time is obtained in consequence of their employment.

Lighting of Leamington.—As a means of supplying a never-failing subject for argument and discussion, the electric light at Leamington has proved a distinct success. The trouble now appears to be as to whether the light given is up to standard or not.

Man Wants but Little, &c.—A strike of engineers occurred on the White Line Electric Road at Dayton, O., for an advance of $2 per day, and the removal of the recently appointed manager who was engaged to promote better discipline. The strikers grounded the wires, and refused to allow the cars to be run back to the power shed. We should think that the rise demanded should read per week, although an American exchange gives the item as above.

Electric Transmission of Power.—When shall we be able to boast of supplying current to electric motors in workshops on anything like even a moderate scale? In New York alone this is done in small units to the extent of nearly 1,500 H.P., and it is expected that in another year the supply will be doubled.

Proposed Electric Lighting at Weybridge.—The Laing, Wharton and Down Construction Syndicate, Limited, having decided to apply to the Board of Trade for a provisional order, enabling them to light the parish of Weybridge by electricity, Mr. Kite, solicitor to the syndicate, and Mr. Rutherford, engineer, attended a meeting of the Chertsey Rural Sanitary Authority last week, for the purpose of explaining the scheme. It was pointed out that the syndicate was already carrying out the electric lighting of the town of Weybridge, but the area now proposed would be more extensive than the district already lighted. In order to obviate the objection to overhead wires, the syndicate was endeavouring to arrange for underground mains, for which, however, it would be necessary to obtain the consent of the local authority. The syndicate would ask for a period of two years in which to arrange for the carrying into execution of this feature of their scheme. After some discussion the authority consented to the provisional order, subject to the overhead wires being removed within two years.

Southampton Corporation and the Electric Light.—Mr. James T. Hamilton, secretary of the Southampton Electric Light and Power Company, Limited, writing on the subject of the recent negotiations with the Corporation of Southampton, for the purchase of the licence acquired by them, states that the corporation first approached the company, and that the offer of concession was made with reluctance. If the directors had foreseen the waste of time and inconvenience which has been occasioned by the delay of the company in coming to a decision, the offer would never have been made.

Electric Etching.—The *Papier Zeitung*, of Berlin, announces that an important discovery has been lately made in the processes of etching and photogravure. The drawing is traced on a plate of zinc by either an artist or by photography, with any suitable etching ground. This plate, backed with asphaltum, is laid in a bath of dilute acid. It is then put in circuit with a dynamo, the other pole being placed in the acid. On the current passing, the acid attacks the metal with extraordinary rapidity. A few minutes are sufficient to bite the plate, the depth of the etching being under easy control.

Electric Lighting in Spain.—The Huelva Gas Company, whose headquarters are at Glasgow, has applied for powers to light the town by electricity. Public opinion is so decidedly against electrical monopolies, that the local authorities have consented to grant the petition only under the condition that the gas company gives up all claims as to priority, &c., and is willing to enter into competition with other electric lighting companies.

The "Peral."—Coincident with the notice that a new Italian submarine boat has undergone successful trials, it is reported that the Spanish submarine boat, the *Peral*, about which the Spanish journals indulged in premature rejoicings, has been abandoned, having proved a complete failure.

Private Lighting on a Large Scale.—Mr. Rockefeller of the American Standard Oil Trust, is said to have spent $150,000 in electric illumination of his park and grounds on the Hudson River.

Cable Testing.—The incident in our last issue, connected with cable testing, which might be termed a new development of the "Hall effect," ought not to be without its advantages. We have often had occasion to draw attention to the tendency of the electrical engineers of the present day to ignore the experiences of old timers in the telegraphic world, which, perhaps, for the future will be deemed worthy of more consideration.

Gay-Lussac.—A statute to Gay-Lussac, by Millet, was inaugurated at Limoges on the 11th. Gay-Lussac was a member of the Academie, and at one time collaborator with Arago and Ampère. He was also "reporter" to the Academic Commission, to whom much of the modern theory of lightning conductors is due. He died in 1850, just after he had commenced to devote particular attention to electric telegraphy. According to one of his biographers, he remarked at the time that it was extremely annoying to have to go just as the fun was commencing; or, in his own words: "Il est véritablement fâcheux de s'en aller, car voilà que cela commence à devenir drôle."

Alternating Current Experiment.—The *India Rubber World* says the experiment was recently tried of sending an alternating current of 1,000 volts pressure through the submarine cable which connects the electrically lighted buoy off Robbin's Reef, New York harbour. The experiment was made to see if the cable would stand the stress without breaking down or developing a fault, and the result was entirely successful as far as the cable was concerned. There was no leakage and no injury to the cable. This cable is insulated with gutta percha and was made by the Bishop Gutta Percha Company. The same company also manufactured the cables which carry current for lighting the six buoys in Gedney's Channel.

Electricity on Wigan Tramways.—The Chairman of the Wigan Tramway Company, after visiting the electrical works of the North Metropolitan Tramway at Canning Town, has presented a report to his co-directors, which states that the system employed would not work well in Wigan, as it could not be relied on. The report complains that the information given in regard to depreciation was scanty.

Death of an American Telegraphist.—Mr. Jeptha H. Wade, one of the pioneers of American telegraphs, died a few days ago at Cleveland. At a time when the financial position of telegraph companies was low, Mr. Wade's company was earning good returns. He constructed the first line west of Buffalo, and covered the whole of Ohio and Illinois with his lines. The well-known "Wade insulator" was invented by him. He leaves a fortune of about five million dollars.

Messrs. Drake and Gorham.—We understand that Messrs. Drake and Gorham have found it necessary, owing to the steady increase of their business, to double the size of their existing offices and stores.

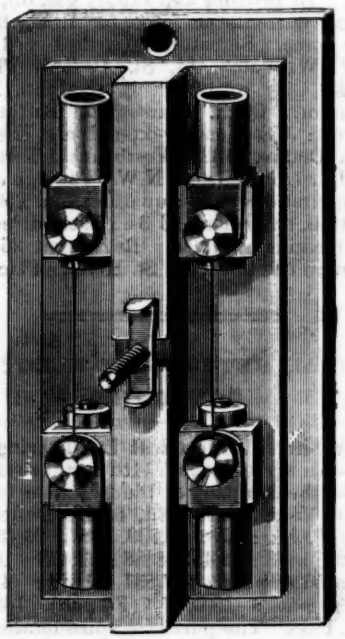
Exportation of Para Rubber.—During the first six months of 1890, says the *India Rubber World*, the United States absorbed 60 per cent. of the total exportations from Pará and Manáos, and about 70 per cent. of the shipments from Pará alone. A comparison of the quality of rubber imported by the United States, and by European countries from Pará, is shown in this table:—

	United States.	Europe.	Total.
Fina (fine)	5,750,716	4,541,919	10,292,635
Entrefina (medium)	1,140,757	877,263	2,018,020
Sernamby (coarse)...	3,483,646	1,569,673	5,053,318
Caucho	702,831	353,014	1,055,845
Totals ...	11,077,950	7,341,868	18,419,81

Elmore Shares.—During the last fortnight a large rise has taken place in the price of Elmore shares, which are at present nearly £7. We also hear that negotiations are pending for the sale of several of the Foreign patents, the price of the Foreign company's shares being now nearly £9 per £5 share.

The Stella Lamp.—It seems that this lamp, a description of which appears on another page, is an old friend in a new guise. Mr. Desmond Fitzgerald could probably claim an intimate relationship with the Star which has suddenly appeared in the French Academy of Sciences.

Binswanger's Patent Improved "H. I." Cut-Outs.—Authorities on electric lighting have repeatedly dwelt upon the fact that the insulation resistance of electric light circuits suffer more from the fittings, switches, cut-outs, &c., used in the circuit, than from any other cause. In such cases, wire of a resistance of 300 or 600 megohms or more per mile has been used, and the leakage is traced entirely to the surface leakage of the china or slate at the back of the fittings. With a view to remedying these serious defects, the General Electric Company, Limited, has introduced a system of china fittings in which such leakage of the current is said



to be rendered impossible. The accompanying illustration shows a double-pole cut-out fitted in accordance with this patented system. The china is divided by a vertical wall, having four china blocks at its sides. To these china blocks are fitted the terminals for the wire, as also the screws for the cut-out. No screws or metal work appear at the back, and thus the leakage of current is obviated. This cut-out also has the advantage over those generally used that the fuse itself can be readily replaced. We understand that other fittings, such as switches, wall-plugs, ceiling roses, &c., are being manufactured by this company upon the same principle.

The High Road to Success.—The Brush Electrical Engineering Company, Limited, has entered into a contract with the London Road Car Company for the supply of 60 omnibuses for horse traction. These omnibuses will be constructed at the Brush Company's Falcon Works, Loughborough, where large extensions have been made to enable the company to cope with increasing demand for their steam engines, tramcars and omnibuses for electric or other traction, rolling stock, and electrical machinery, and apparatus of every description.

Electricity and Advertising.—Messrs. Pyke and Harris are adapting the use of vacuum tubes, in conjunction with Messrs. Pyke and Barnett's high-tension transformers, to the purposes of advertising, under the impression that letters or designs scintillating with the soft light of electric glow cannot fail to attract attention as much by their beauty as by their singular and entirely novel appearance.

The New Spanish Cables.—With regard to these cables, referred to in our issue of last week, the *Daily Telegraph* of August 25th contains the following announcement:—"The Foreign Office has issued the following: The Spanish Minister of the Interior, by a notice dated the 18th inst., has invited tenders for the construction and laying of telegraphic cables between Spain and the Spanish possessions on the north coast of Africa and to Tangier. Seven sections, of a total length of 332 miles, will be required. The maximum payment to the contractor will not exceed about £160 per mile. These tenders are to be addressed, in sealed covers, to the Director of Posts and Telegraphs, Telegraphic Department, No. 18, Calle de Claudio Coello, Madrid, and must be sent in within 30 days from the 18th inst. The conditions (in Spanish) may be seen at the Commercial Department of the Foreign Office, London, between the hours of eleven and five."

Exhibition at Palermo.—A National Exhibition will be held at Palermo next year. The committee has resolved to organise an electrical section in order to show the progress recently made in the various applications of electricity. It is proposed to make a larger display than those at the Milan and Turin exhibitions. The reasons why rapid development is taking place in Italy are the absence of gas works in many towns, the lack of a sufficient supply of coal, and the abundance of natural water power.

Cable Laying.—A very interesting article on cable laying appears in the *Cornhill Magazine* for September, a copy of which has been sent to us. It is not difficult to guess the quarter from whence it comes, and to those who desire to become acquainted, after half an hour's pleasant reading, with most of the operations connected with girdling the earth, we cordially recommend the paper.

The Tory Island Cable.—At noon, on August the 26th, the Duke and Duchess of Abercorn inaugurated the new signal and telegraph station on Tory Island. On approaching the island in the steamer *Thistle*, the Duchess threw overboard a floating box containing a number of telegrams, among them one addressed to the Queen, expressing congratulations on the establishment of telegraphic communication with the most westerly portion of Ireland.

Probable Electric Lighting at Sheerness.—The Sheerness Local Board of Health is considering the advisability of adopting the electric light for the town in place of gas, and has given instructions to their surveyor, Mr. W. W. Copland, to supply them, at their next meeting, with information on the subject.

The Infant Dynamo.—A memorandum from Messrs. Page and Miles, of Brighton, informs us that they have recently completed an electric light installation at Tudor House, Burgess Hill, the machine employed being an Austin "Infant" dynamo, 200 watts, shunt-wound, driven by a two-man gas engine, E.P.S. accumulators being used to regulate the current.

Rashleigh Phipps and Dawson.—Church lighting is making progress. Messrs. Rashleigh Phipps and Dawson have just received the order for a complete installation for the church of St. John the Divine, Kennington. The Royal Standard Music Hall, and St. Martin's-in-the-Fields Free Public Library, are also in the hands of the same firm.

Personal.—We referred in our issue of August 15th to the resignation by Mr. A. R. Bennett of his post of general manager to the National Telephone Company, Limited. We understand that differences with the directors was the cause. Since the amalgamation, last year, the operations of the extended National Company, which has nothing in common with the old National except the name, have been chiefly directed by gentlemen who were directors of the old United Telephone Company which worked London, and of the old Lancashire and Cheshire Company. Mr. Bennett, who had previously been unable to agree with the policy of the new board on several important points, determined, towards the end of July, on an event of an extraordinary nature occurring which showed cordial co-operation in the future to be hopeless, to sever his connection with the company at the earliest possible date—October 31st.

We understand that Mr. F. G. Thomas, of the Manchester Edison-Swan Company, Limited, has resigned his appointment as storekeeper of that company, and has left this country for Australia, where he will join the Williamson Electric Light Company of Sydney.

The Bermudas-Halifax Cable. — Messrs. Henley's telegraph cable ship *Westmeath*, lately engaged in the laying of the Bermuda-Halifax section, returned to the Thames on the 19th inst., having successfully completed the laying of the cable from Halifax, Nova Scotia, to the Bermudas. The expedition left the Thames on the 23rd May last, so that the whole work has been accomplished (including the guarantee period of 30 days) within three months. Eight soundings were taken near Bermuda in the main route of the cable, which showed a regular increase in depth from 24 to 1,240 fathoms, the steepest gradient found being about 1 in 4. Soundings taken on the Halifax side for the purpose of defining the slope of the bottom from the deep water up to the edge of the flat, which extends for nearly 100 miles outside Halifax, showed a regular decrease from 1,089 to 118 fathoms. The carrying out of this work reflects the greatest credit on Messrs. Henley's staff, it being well known that the laying of this cable presented exceptional difficulties, in fact, the strongest doubts have been expressed by authorities as to the possibility of laying such a cable successfully. We understand that the same vessel has been chartered by Henley's Telegraph Company for the laying, in the West Indies, of those cables which will form an extension southward of the system owned by the Société Française des Télégraphes Sous-Marins. As our readers are probably aware, the cables already laid on behalf of this company are :—

Aguadores (Cuba) to Caimanera (Cuba) ...	50	N.M.
Caimanera (Cuba) to Mole-St.-Nicolas (Hayti)	126	,,
Mole-St.-Nicolas (Hayti) to Puerto Plata (St. Domingo...	188	,,
St. Domingo (St. Domingo) to Curaçoa ...	453	,,
Curaçoa to La Guayra (Venezuela)	163	,,
	980	N.M.

Newspaper Enterprise.—The *Times* newspaper spent over £6,000 in telegraphing day-by-day the news of the revolution in Buenos Ayres.

Electric Light Wanted in the Bermudas.—A writer to a New York daily states that there are no electric lights on the islands, but that the principal inhabitants "want them badly." He mentions a dozen persons who would go to a heavy expense in order to have the electric light.

NEW COMPANIES REGISTERED.

United Flexible Metallic Tubing Company, Limited.—Capital, £75,000 in £10 shares. Objects: To amalgamate the Flexible Metallic Tubing Company, Limited, and the Belgian and Colonial Flexible Metallic Tubing Company, Limited, and to carry on the business of mechanical engineers, electrical engineers and metallurgists. Signatories (with 1 share each): Claude Scott, 15, Arkwright Road, N.W.; R. Henderson, C.E., 8, Draper's Gardens; R. T. Hewlett, M.R.C.S., 28, Keppel Street, W.C.; A. H. Bacon, 30, Bridge Avenue, Hammersmith; J. W. Hewlett, 105, Bennerley Road, Wandsworth Common; S. Wade, 76, Santley Street, Clapham Common; J. D. Jones, 5, Ryde Terrace, Stockwell. The first directors are F. Walton, 4, Portugal Street, W.C.; G. Marsham, Maidstone; A. J. Thornton, 36, Rosary Gardens, S.W.; qualification, £250 in shares or stock; remuneration, chairman £200 per annum, each director £100 per annum. Registered 20th inst. by R. Hewlett, 31, Essex Street.

Lamp Manufacturing Company, Limited.—Capital, £16,000 divided into 1,000 preference shares of £10 each, 3,000 ordinary, and 3,000 deferred shares of £1 each. Objects: To adopt an agreement with the Redsdale Railway Lamp and Lighting Company, Limited, and its liquidator, Mr. Edward Cecil Moore. To manufacture lamps of all kinds, and apparatus for the consumption and supply of gas, oil, and electricity. To carry on business as mechanical, gas, and electrical engineers. To produce and supply gas, oil, electricity, or electrical currents or force, for light, heat, motive power, or force. Signatories (with 1 ordinary share each): W. W. Paine, 14, St. Helen's Place; J. J. Collins, 45, City Road: P. E. Chalhon, 18, Saltoun Road, Brixton; C. R. Pearson, 2, Balfour Terrace, Leytonstone; J. E. Wood, Dexter House, East Dulwich; R. Sutton Clarke, 132, Westbourne Terrace; C. J. Harper, 39, Leighton Grove, N.W. The signatories are to appoint the first directors; qualification, £50 in shares; remuneration, chairman, £3 3s.; each director £2 2s. for every meeting attended. Registered 26th inst. by Paine, Son and Pollock, 14, St. Helen's Place, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Vaughan-Sherrin Electrical Engineering Company, Limited.—An agreement of 11th inst. provides for the purchase by the company of the following letters patent from John Vaughan-Sherrin, of 19, Duncan Terrace, Islington, N., viz. :—No. 15,730, 1887; 20, 1888; 2,666, 1888; 5,390, 1888; 12,455, 1888; 13,473; 10,647, 1889. Patents applied for :—17,831, 1889; 4,767, 1890. Foreign patents :—19,2907 (French), 1888; 83,228 (Belgian), 1888. The purchase consideration is £3,000 in cash, fully-paid founders' shares, and fully-paid ordinary shares, equal to the number otherwise allotted, so that the vendor and his nominees shall hold one-half of the shares of the company.

The registered office of this company is at 48, Eagle Wharf Road, Hoxton.

Northern Electric Wire and Cable Manufacturing Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 17th ult. and filed 18th inst., directs the striking out of the name of Edward William Hall, of Park House, Bradford, from the register of shareholders, as a holder of 160 shares. It is also ordered that the sum of £80 paid by him upon his application for shares be forfeited, together with interest thereon at the rate of 4 per cent. per annum from 4th July, 1889, to the date of repayment, and also the costs of his application to the Court, to be taxed by the taxing master.

The annual return of this company is made up to the 4th March. The nominal capital is £20,000, divided into 660 fully-paid up vendors' shares and 3,340 ordinary shares of £5 each. Upon the latter £1 10s. per share has been called, the calls paid amounting to £945 10s., and unpaid to £17 10s. The sum of £80 has been paid upon 160 shares forfeited since the return of the 12th November, 1889.

Baxters, Limited (general mechanical, marine and electrical engineers).—At an extraordinary general meeting of the members of this company, held at the registered offices, Sandiacre, near Nottingham, on the 15th ult., it was resolved that the directors may, notwithstanding any rule of law or equity to the contrary, contract on behalf of the company for the purchase from four of their number, viz.: S. Pryer Baxter, Frederick Baxter, A. N. Baxter, and C. H. Baxter, the goodwill and assets of their business at Sandiacre, at the price of £19,950, and which purchase may date from 1st June last. The resolution was confirmed on the 31st ult., and duly filed 1st inst.

Beales, Limited (confectionery and electricity).—At an extraordinary general meeting of this company, held at 370, Holloway Road, on the 14th ult., it was resolved to wind up voluntarily, Mr. H. S. Shipton, of Ellendale, Crescent Road, Crouch End, being appointed liquidator. The resolution was confirmed 31st ult., and duly filed 2nd inst.

Head, Wrightson and Company, Limited (engineers' and bridge and pier builders, and electricians).—An agreement of 24th June, filed 2nd ult., provides for the purchase of the business of this firm, carried on at South Shields. The purchase consideration is £310,000, payable £240,005 in cash, and the residue in fully paid shares.

John Wright and Company, Limited (gas, electrical and general engineers).—An agreement of 26th June, filed 11th inst., provides for the purchase of the business of the firm of John Wright & Co., of the Essex Works, Aston Junction, Birmingham, for £85,183, payable £49,183 in cash, and the residue by the allotment of 100 debentures of £100 each, 2,600 preference shares of £5 each, and 2,600 ordinary shares of £5 each.

Elmore's Wire Manufacturing Company, Limited.—The following resolution, passed at an extraordinary general meeting, held at Cannon Street Hotel on the 14th ult., was confirmed at a meeting held at 20, Bucklersbury, on the 6th inst., and was duly filed on the 18th inst., viz.:—"That the following clause be substituted for Clause 80 of the articles of association: 'The company may make contracts with any of the directors upon such terms as the directors shall think fit, and a director shall not, by reason of the fiduciary relation subsisting between him and the company, be accountable for any profits made by him in respect of any such contract, nor, subject to the following proviso, in respect of any other contract made with the company in the profits of which he participates, or in which he is otherwise interested; provided that the fact of his being so interested therein, and the nature of his interest, be fully and fairly disclosed by him at the meeting of directors at which the contract is determined on, if his interest then exists, or in any other case at the first meeting of the directors after the acquisition of his interests; but, in the case of contracts with companies or firms of which any director of the company is a member, it shall not be necessary to disclose more than the fact of such membership, provided always that in no case shall such director so interested vote, or, if he does vote, his vote shall not be counted.'"

Elmore's Patent Copper-Depositing Company, Limited.—The annual return of this company, made up to the 11th August, was filed on the 18th inst. The nominal capital is £200,000 in £2 shares; 70,000 shares are taken up, and of these 23,300 are considered as fully paid up. Upon 46,700 shares the full amount has been called and paid, the paid up capital thus being £93,400. The sum of £7 18s. has been received upon 15 shares forfeited.

Edison and Swan United Electric Light Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 21st inst. The nominal capital is £1,000,000, divided into 150,000 "A" and 50,000 "B" shares, of £5 each. The shares taken up are 89,261 "A," upon which 10s. per share has been called, 17,139 "A," considered as fully paid, 23,564 "B," considered as fully paid. The calls paid amount to £223,152 10s.

Plymouth and District Pulsion Telephone Company, Limited.—An agreement of 13th inst., filed 20th inst., provides for the purchase by the company from the Primary Sydicate, Limited, of a licence to use the letters patent No. 8,457, dated 9th June, 1888, granted to Lemuel Mellett for improvements in mechanical telephones. The purchase consideration is £3,100, payable £100 in founders' shares and £3,000 in ordinary shares, all fully paid.

Sheffield Telephone Exchange and Electric Light Company, Limited.—The annual return of this company, made up to the 20th inst., was filed on the 28th inst. The nominal capital is £60,000 in £10 shares, the whole of which are taken up. Upon 923 shares the sum of £8 per share has been called. There has been called on 3,077 shares an aggregate sum of £10,770, being the balance due on the said shares after deducting the £7,692 considered as calls paid. The calls paid amount to £17,988, and unpaid to £166, and £33,846 is considered as paid upon 5,077 shares.

City of Westminster Electrical Syndicate, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 20th inst. The nominal capital is £20,000, divided into 10,000 shares of £1 each, and 1,000 shares of £10 each. The whole of the £1 shares have been taken up, and the full amount has been paid thereon.

Parker's Electric Wire Corporation, Limited.—A meeting of this company was held on the 12th inst., when an account was given as to the manner in which the winding up of the company has been conducted, and its property disposed of.

Consolidated Telephone Construction and Maintenance Company, Limited.—The annual return of this company, made up to the 12th June, was filed on the 20th inst. The nominal capital is £307,545, divided into 75,000 6 per cent. preference shares of £1 each, 224,850 ordinary shares of 14s. each, and 75,150 ordinary shares of £1 each. The shares taken up are 25,000 preference and 224,850 ordinary shares. Upon each preference share £1 has been paid, and upon each ordinary share 14s. The calls paid amount to £182,395.

CITY NOTES.

The West Metropolitan Tramways Company.—At the meeting of this company, held this week, the chairman, Mr. E. H. Bayley, in the course of his remarks on the position of the company, referred to the action of the various local authorities through whose district the company's line ran, and quoted from the remarks from Mr. Webb, their solicitor, at the last meeting on the question of electrical traction. Negotiations had been in progress in respect to this matter for several months, but eventually the electrical company withdrew their proposal. It was satisfactory, however, that fresh negotiations were in progress with another electrical company, who offered to undertake the work on advantageous terms as soon as the local authorities should have given their sanction. He moved the adoption of the report. Mr. J. W. Greig seconded, and his motion was carried. The proceedings terminated with a vote of thanks to the chairman.

The Electric Construction Corporation, Limited.—The Committee of the Stock Exchange has ordered shares Nos. 101 to 45,100 of the corporation, to be quoted in the official list.

The Petroleum Engine Company, Limited.—A meeting of shareholders was held at the company's offices, 23, Queen Victoria Street, E C. The proceedings were not open to the press.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending August 22nd, were £5,121.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 22nd, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,90

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 21.)	Closing Quotation. (August 28).	Business done during week ending August 28, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 —100	97 —100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50½— 51½	50½— 51½	50¾	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	87 — 88	87½— 88½	88	87½
2,725,420	Do. do. Deferred	Stock	14¾— 15¼	15¼— 15⅝	15½	14¼
130,000	Brazilian Submarine Telegraph, Limited	10	11⅞— 12¼	11⅞— 12¼	12	11⅞
99,000	Do. do. 5 p. c. Bonds...	100	100 —102	100 —102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 —107	103 —107	103	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	1½— 2	1½— 2	1⅝	...
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1½— 2	1½— 2	1⅞	...
$7,216,000	Commercial Cable, Capital Stock	$100	103 —105	102 —104		
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	9/16— 11/16	9/16— 11/16		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½— 5¾	5½— 5¾		
16,000	Cuba Telegraph, Limited	10	12⅝— 13 xd	12⅝— 13		
6,000	Do. do. 10 p. c. Preference	10	16½— 17½xd	16½— 17½	17½	...
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3½— 4	3½— 4		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½— 10¾	10¼— 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅞— 14¼	13¾— 14⅛	14¼	13⅞
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅝	15
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 —109	106 —109		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	106	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14¼	14 — 14¼	14¼	14 3/16
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 —103	100 —103		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	... ...	7¾—8¼		
19,100	*Electricity Supply Co. of Spain, Nos. 101 to 20,000 ...	5	4¾— 5¼	4¾— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	6 — 6¼	6⅞— 7¼	7¼	6 9/16
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2 — 2¼	2 — 2¼		
180,227	Globe Telegraph and Trust, Limited	10	8¾— 9¼	8¾— 9¼	9 1/16	8¾
180,042	Do. do. 6 p. c. Preference	10	14¾— 15¼	14⅝— 15⅛	15⅛	14 11/16
150,000	Great Northern Tel. Company of Copenhagen	10	15¼— 16	15¼— 16	15¼	...
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 —103	100 —103		
250,000	Do. do. do. (issue of 1883) ...	100	106 —109	106 —109		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½		
200,000	Do. do. 4½ p. c. Deb., 1896...	100	102 —104	102 —104		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
109,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4 — 4¼	4 — 4¼		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4¾— 5	4¾— 5	4 15/16	4¼
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½	12¼	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	⅛— ¼	⅛— ¼		
9,000	Reuter's, Limited	8	7¾— 8¼	7¾— 8¼		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ⅛	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½— 3	2½— 3		
3,381	Submarine Cables Trust	Cert.	113 —117	113 —117		
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5 — 5½	5 — 5½	5 3/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43¼	43
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102	100⅛	...
55,000	United River Plate Telephone, Limited	5	3½— 4½	3½— 4½		
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	102	101¼
30,000	West Coast of America Telegraph, Limited	10	3 — 5	3 — 4	3¼	3 3/16
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	106 —110	103 —108	105¼	...
64,572	Western and Brazilian Telegraph, Limited	15	11¼— 11¾	11¼— 11¾	11 1/16	11⅛
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7¼	6¾— 7¼		
26,986	Do. do. do. 5 p. c. Deferred	7½	4¾— 5¼	4¾— 5¼	5¼	4¾
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	103 —106	103 —106		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104	101 —104		
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	2¾— 3	3	2 15/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	11⅝	11⅝
4,069	Do. do. do. 6 p. c. 2nd Preference ...	10	13 — 14	13 — 14		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¼— 1⅝	1¼— 1⅝		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—Elmore Copper Depositing Priorities, 7 —7½.—Elmore's Wire, ¼ dis—par.—House-to-House Company (£5 paid), 5 —5¼.—International Okonite, Ordinary of £10 (£4 paid), 3¾—4¼ London Electric Supply Corporation, Ordinary (£5 paid), 1¾—2¼.—Manchester Edison and Swan Company, £9 (£1 paid), 11/- —13/-.

BANK RATE OF DISCOUNT.—4 per cent. (21st August, 1890).

THE SANITARY ASPECTS OF ELECTRIC LIGHTING.*

By W. H. PREECE, F.R.S.

THE chief tendency of modern legislation in our British Parliament is to improve the environments of the human frame, so that we may live, and move, and have our being with greater health to the individual, and greater prosperity to the nation. The cleanliness of dwellings, the drainage of towns, the removal of filth, the suppression of nuisances, have not only been specified but the inspection of the means to effect these objects, and of their results, are defined and insisted upon by Acts of Parliament. People often speak disrespectfully of our grandmotherly Government, but at least in this region of domestic legislation, the control it has exercised over the food we eat, the water we drink, the air we breathe, is of a true parental order, and deserves our unreserved admiration and respect. The Home Office and the Local Government Board act the part of a wise and economic head of the house to the nation, while each community has its own Local Board or Authority to carry out hygienic provisions, to enforce sanitary principles, to prevent infection, to stamp out disease, to sweeten labour, and to prolong life.

I contemplated at one time submitting an historical summary of these features of sanitary legislation during the present generation, but not only would the task be very onerous, but it would be so lengthy that I should have very little time left to discuss the question set before me—the sanitary aspects of electric lighting.

The propositions that I propose to submit and to demonstrate to you are these:—

1. That electricity and light being analogous and identical forms of energy, the former is naturally the proper source of artificial illumination.

2. That all other sources of artificial illumination being dependent on the absorption of oxygen, and resulting in the vitiation of air are injurious to health.

3. That the same authority which regulates the sanitation of our dwellings, and the supply of our food, should also control the purity of the air we breathe, and of the light we work by.

Light, however it be produced artificially, is simply the equivalent of work that has been done elsewhere. Whether it be by the combustion of tallow or oil, by the burning of coal or of gas, by the glowing of a fine wire, or the formation of the brilliant arc, energy has been expended somewhere, to be transferred and reproduced in some other place in the form of light. The great principle of the conservation of energy teaches us that the amount of energy in the universe is a fixed quantity, that it can be neither created nor destroyed, that it can only be transferred, and that any expenditure of energy—work done—anywhere is the equivalent of energy utilised somewhere else. The rate at which this energy is expended is called *power*, and the amount of power which we foolishly call a *horse-power*, and which we roughly imagine to be equivalent to the power exerted by a horse in drawing a load along a road, is competent to produce an amount of light which is very simply measured. Our standard of light is the light given by a No. 6 sperm candle, burning 120 grains per hour. Now the energy of one horse-power constantly expended will give by the aid of

Tallow	the light of 6 candles	
Sperm	,,	8·7 ,,
Oil...	,,	9 ,,
Gas	,,	13 ,,
Electric current—Glow	,,	248 ,,
,, Arc	,,	1,492 ,,

The results to the air of these different modes of producing artificial illumination are well shown by the following table:—

Products of Combustion in developing 100 *candles per hour.*

Illuminant.	Quantity Consumed.	Carbonic Acid produced.	Water Vapour.	Heat.
	lbs.	cub. ft.	lb.	Calories.
Tallow	2·2	51·2	2·3	9,700
Sperm	1·7	41·3	2·0	7,960
Oil	1·3	33·6	1·8	7,200
Gas	56 cub. ft.	40·3	2·5	12,150
Electricity	(Coal) 2·2 lbs.	0	0	257

Thus we see how very much more efficient electricity is than any other agent for the production of light.

The great hygienic advantage of the electric light when illumining our dwellings and our workshops, is not that it purifies the air, but that it prevents the air from being vitiated by the introduction into it of the products of combustion, such as carbonic acid, carbonic oxide, sulphurous oxide, &c.; it prevents the air from being weakened by the abstraction of oxygen, and it prevents it from having its temperature raised by undue radiation, and by throwing into it heated gases.

While legislation and the greatest possible stringent regulations have been drawn up to prevent the adulteration of food and the poisoning of water, scarcely any attention has been devoted to the prevention of the admission of noxious gases and poisonous vapours into the air of our habitations. Carbonic oxide is a poison of the deadliest character, and gas jets are freely used which deliver copious discharges of this dangerous gas into the atmosphere of our rooms. If we were consistent in our legislation, we ought to forbid the use of any burner which thus poisons the air. A man at rest exhales ·0424 cubic feet of carbonic acid gas (CO_2) and ·1189 cubic feet of air per pound weight per hour, while a gas jet burning 5 cubic feet of coal gas exhales 4 cubic feet of CO_2. The maximum proportion of CO_2 to air consistent with health is 6 volumes in 10,000, 10 volumes affect the heart, and 30 volumes produce headaches. Rheumatism, bronchitis, and other ailments proceed from higher proportions. In fact, 5 cubic feet of gas requires 8,000 cubic feet of pure air per hour to maintain it healthy. The electric light requires no such provision.

That the electric light is a powerful element of health is evidenced by the fact that those who use it not only feel all the better for its introduction, but their appetite increases, and their sleep improves, and the visits of the doctor are reduced in frequency. Workpeople work all the better, and absences from illness are far less frequent. In the Savings Bank in Queen Victoria Street, London, where 1,200 persons were employed, the absences from illness were so far reduced, that the extra labour gained paid for the electric light. In Liverpool and many other places the same result has been observed.

The influence of artificial light on the eyes has a very important sanitary bearing. Why is it that there is so much short-sightedness in the present day? Is it due to our mode of producing light? Some assert that the injury to the eyes is due to the heat rays and not the light rays. If that be so the electric light must be much less injurious than any other. On the other hand, no one can have experimented with arc lamps without having had his retina painfully affected, which leads one to think that the ultra-violet rays have some influence. No one has, however, ever complained of the influence of a steady glow lamp upon the eyes, and it is possible to read and to write for many hours by such a light without experiencing the least fatigue.

The electric current is not altogether free from being a cause of fire, and though its use is by no means very general, still it is used sufficiently to make itself felt as an element of danger in this respect. The following table shows the number of fires in London which can be traced to the different methods of lighting:—

	1887.	1888.	1889.	Total.
Lamps	245	205	257	707
Gas	188	197	209	594
Candles	142	113	136	391
Electricity ...	0	1	2	3

The progress of the electric light in our homes has been much more rapid in England than in any other country, but its employment for street-lighting, for shops and manufactories, has been infinitely more rapid and extensive in the United States than with us. In America the growth has been enormous. There are now 250,000 arc lamps, illuminating the public streets and shops, and 300,000,000 glow lamps in dwellings, stores, and workshops.

The following table shows the development of the Berlin Central Stations:—

Station.	Effective of Horse-Power.						
	1884.	1885.	1886.	1887.	1888.	1889.	When Complete.
Friedrickstrasse...	300	300	300	300	300	300	300
Markgrafenstrasse	...	1000	1000	1000	2100	2400	3100
Mauerstrasse ...	...	...	500	1250	1250	2950	4950
Spaudauerstrasse	...	...	...	...	...	2000	4000
Schiffbauerdamm	...	...	...	...	...	1000	6000
Total	300	1300	1800	2550	3550	8650	18350
16 C.P. lamps, or equivalent ...	2500	4600	13229	21660	34750	...	...
Kilometres of cable	...	8	10	15	25	75	...

The progress in England has been very much checked by inordinate speculation, and by terrible failures in some of the earlier work done. There is something very captivating in the practical applications of electricity, and something romantic in its mystery. The neophyte has rushed into it with remarkable fervour, and the lessons of failure have in consequence been very severe. The users of the light have also been paying heavily for the education and experience of amateur tradesmen and inexperienced contractors, and have neglected to avail themselves of the professional services of the experienced electrical engineer. People who would not build houses without the architect, nor construct bridges without the engineer, nor make their wills without the lawyer, rush wildly into the use of electricity without any professional assistance, where, above all things, experience and knowledge are essential to prevent disaster and disappointment. Large installations have been completed without specifica-

* Abstract of paper read before the Sanitary Institute, Brighton, August 26th.

tions to guide the contractor, and without inspection to see that the work has been properly done. The user has paid violently for his temerity, and fires and accidents have been the result. The heavy price of wiring a rented house, and the expensive character of the fittings proposed, have deterred many from adopting the light, even when it is within their reach. Highly insulated wire is unfortunately expensive. All cheap wires are nasty and dangerous. There is nothing that becomes the electric light better than simplicity, and its effect is frequently marred by elaborate brass work. It possesses also most active and wide-spread opponents, both in oil and gas—opponents who have benefitted by its introduction, and who are not slow to profit by its advance. The improvements in gas and oil lamps are as marked as the advancements in electric light, and as means of artificial illumination alone—that is as far as light-giving power is concerned—there is little choice between the three, but oil and gas cannot lose those elements of discomfort and ill-health which differentiate them from the cool and pure glow lamp.

A very important question arises for discussion. Legislation has slipped in to place the virtual control of the supply of electrical energy in the hands of the local authority of the district to be served. Is this supply to be the result of the capital of private enterprise, or is it to be effected by raising money on the security of the rates?

It is argued that the supply of electricity being a purely commercial undertaking, it should therefore be carried out by a limited liability company. The Acts of 1882 and 1888 do not encourage monopoly, but rather court competition, and competition attracts capital. Competition properly regulated and controlled secures economy in supply, and certainly enforces economy in working, while it encourages improvements, and induces perfection of apparatus and novelty in processes. These arguments are plausible, but are easily refuted by those who desire to uphold vested monopolies. Direct competition always means ultimately enhanced cost to the public, for the same public has to pay for double plant, and each competitor only gets half revenue.

The supply of light is in precisely the same category as the supply of water or the supply of gas, and the days have certainly passed when the public will tamely submit to the transference of their right to such vested interests as those of gas or water companies.

It is very easy to argue *pro* or *con* on each side. The local authority has to regard the security of traffic, the safety of person, the repression of crime, and the proper supervision of the premises of its ratepayers. It is the custodian of the public interests. It has to control the health, cleanliness, comfort, and beneficial sanitation of its habitable dwellings. It therefore must secure the best light, and if it can do this, and at the same time relieve the rates which are generally creeping up to dangerous dimensions, then its action would be wise and economical. But it would be entering into commercial rivalry with an active competitor—the gas companies; and its commercial control by such a shifting authority as a committee of a Town Council or of a Local Board, subject to the changes of political warfare—to the vagaries of press dictation, and to the fear of November elections—is a very doubtful proceeding. On the other hand, in many instances, such bodies have successfully dealt with the water question, the tramways, and even with the gas. In fact, one-third of the gas capital (21 millions) in this country is in the hands of 173 Local Authorities, and more than half a million of profits go to the reduction of rates.

Bradford has already grappled with the question. It has established a central station for the supply of the electric light. Brighton, St. Pancras, and Bristol are doing the same, and many other places are following suit. They are shying at the probability of handing over their districts to a speculative company, with a virtual though not a legal monopoly, to supply electrical energy for 42 years. Many corporations contemplate a middle course. They have obtained the power for themselves, but they have farmed for shorter terms the right of supply to private enterprise, which can do what they are afraid to do, viz., speculate and experiment. The Board of Trade has sanctioned and facilitated such a transfer of statutory rights.

It is surprising that gas administrations in England have not been more enterprising in developing electric lighting. In Vienna, Rome, and Stockholm the gas companies have established central stations, and the progress of the industry in these cities is very great. The proper function of gas is to supply heat, not light, and as a source of power it has a future more brilliant than its past. If it could be supplied as fuel it would remove the troubles of coal transit and storage, of ash and dust removal, of smoke and of stoking. It has even been shown that it is cheaper to convert coal into gas on the spot, and to use the gas as the source of power, than to apply the coal direct for the production of steam in boilers. The waste of energy in the use of coal is enormous. The energy contained in one pound of coal if burnt in one hour is theoretically sufficient to supply 5·6 horse-power for that hour. The best practical result yet obtained by the steam engine is scarcely one horse-power.

The electric light is unquestionably the light of the future. Its use is advancing with leaps and bounds. Not only is it naturally the proper source of light, but economically it must eventually supplant its rivals. When electrical energy is generally distributed through our towns, and its supply is continuous, and properly controlled, so that it is always within the reach of all; and when means can be devised to wire up houses as cheaply as they are now fitted for gas, everyone will take it, not alone for its beauty, but because it is, above all, a source of health and comfort.

THE BERMUDA-HALIFAX CABLE.

THE following particulars of this cable may be of interest to our readers:—

The core is composed of seven copper wires stranded, weighing 120 lbs. per N.M., and of three coats of gutta percha, weighing 150 lbs. per N.M. The core is covered throughout with a serving of jute yarn, steeped in a preservative mixture and then whipped with 3-ply jute yarn.

The conductor resistance is stated to be 10·5 ohms per N.M., at a temperature of 75° Fahrenheit; the dielectric resistance after 24 hours' immersion in water at the temperature of 75° Fahrenheit, was to have been not less than 1,000 megohms after one minute's electrification.

In the deep sea type the core is sheathed with 16 galvanised homo wires, each ·099 of an inch in diameter; the outer covering consists of two coats of Russian hemp laid on in opposite directions, and three coats of bituminous compound. The weight of this type, wet in air, is about 1·8 tons per N.M. The sheathing for the light intermediate cable is composed of 12 galvanised iron wires, each ·165 of an inch diameter; the outer covering is the same as in the deep sea type. The weight of this type, wet in air, is about 3·5 tons per N.M. The core, in the heavy intermediate type, is sheathed with 12 galvanised iron wires, each ·220 of an inch diameter; outer covering same as before. This type weighs, wet in air, about 6 tons per N.M.

For the Bermuda shore end the core is first sheathed with 12 galvanised iron wires, each ·165 of an inch diameter, a sufficient serving of jute and compound is then laid on, and this is then covered with an outer sheathing of 12 strands of three wires each, each wire ·203 of an inch diameter. The external covering is the same as before. This type weighs about 19 tons, wet in air, per N.M.

According to the *Bermuda Royal Gazette*, the Halifax shore end is of a lighter description, having only one sheathing, and weighing only about 10 tons per N.M.

The *Westmeath*, a steamer chartered by Henley's Telegraph Company for the laying of the cable, is a vessel of some 4,500 tons. She left the Thames on May 23rd, carrying 874 N.M. of cable. She was under the command of Captain Stonehouse, the engineer-in-charge being Captain Stiffe, late of the Indian Marine. Mr. Peake, of the firm Clark, Forde and Taylor, represented the Halifax and Bermudas Cable Company.

The *Westmeath* anchored at Bermuda on the 6th June, and left on the 12th to sound along the route of cable, completing the soundings commenced by the *Challenger*. The vessel arrived at Halifax on June 16th. It is stated that the soundings were taken 100 miles apart, except near the land, where they were made at close intervals. The deepest water found is said to have been 2,820 fathoms, with a bottom temperature of 34·4° Fahrenheit. The laying was commenced from the Halifax end on the 25th June, arriving off Bermuda on the 30th, the final splice being made on the 7th July, some difficulty having been experienced in the laying of the shallow water portion, light draught vessels being employed for the purpose. The total length laid was, we understand, about 850 N.M.

The capital of the company is £120,000, in 4½ per cent. first mortgage debentures, and £50,000 in ordinary shares of £5 each. The English Government grants a subsidy of £8,100 per annum for 20 years.

It is stated that considerable traffic will be obtained between Bermuda and New York, and that some revenue will arise from ships which, it is hoped, may make the Bermudas a port of call. We presume that some business beyond that which may proceed from casual winter visitors from the States, or from an occasional vessel in distress, is anticipated. No doubt the cable is of importance as connecting two British naval stations, but this fact does not necessarily imply a paying investment.

REVIEWS.

Electric Light Fitting: A Handbook for Working Electrical Engineers. By JOHN W. URQUHART. London: Crosby Lockwood and Son, 1890.

The volume before us is an attempt to state in the simplest language the precautions which should be adopted in installing the electric light, and to give information for the guidance of those who have to run the plant when installed. It is addressed to intelligent men who are engaged in the electrical industry, or being trained for it, special attention being given to the branches known as "fitting" or "wiring." As might be expected, the contents cover a somewhat extended area of practice, and a deal of information which may prove useful to the expert as well as to the working electrician is given. As a book justifying its pretensions it can be recommended, though in many instances we do not find ourselves in agreement with the author. At page 11, for example, the author is not at all clear regarding the reason for giving the brushes a lead, and does not seem to know that when a lead is given they are still almost at right angles to the lines of force, the latter being twisted, however, by the armature current. We should like to know the names of the electricians referred to who have made the calculations showing that machines without iron in their armatures require no lead. On page 32 the author refers to the pumping or pulsating of arc lights, and mentions that extinctions and rapid self re-lighting sometimes occur. This is unfortunately true, but Mr. Urquhart does not explain that the reason of this misbehaviour is mostly due to faulty proportion in the dynamo, which has to be carefully guarded against by those who manufacture closed coil arc machines. The author is a little behind the times in advocating the insulation of the armature core from the shaft. No good machines are made so now-a-days, nor is it necessary, even for the highest E.M.F. The remarks about the coupling of alternators in parallel are extremely weak, and the instructions to the attendant are not at all clear. Regarding the running of arc lamps in parallel, it is said, they "work very well when fitted with resistances or choking coils, as they are called." Here the author fails to distinguish between resistances and choking coils, two things which are essentially different in principle and construction. We should say the author's knowledge of arc lamps and their working has been derived mostly from books.

Coming to the question of loss between the dynamo and the lamps, a limit to this is set at 5 volts. In our opinion, this variation is far too much to allow, and 2½ volts would be nearer the mark. In talking of the series system of incandescence lighting, the author says that it is impracticable when carried beyond a few lamps, as a line of 50 lamps of 100 volts would call for 5,000 volts. Of course no engineer in his senses would for a series system use 100-volt lamps, so this argument is quite untenable. An alternator working direct on to lamps is said to be less liable to breaks-down than a direct current machine, as there is no commutator to get out of order, but surely the exciter commutator is as likely to go wrong as would be the commutator of the large machine if it were direct instead of alternating, so here we fail to see an advantage.

There are many more statements to which we take exception, but space will not permit us to notice them. Though there is much that might be objected to on the grounds of scientific inaccuracy, the book, on the whole, is well worth the perusal of the workman, for whom it is written. If we cannot have a practical work scientifically accurate, we must be content with the nearest approach to it we can get.

The Labour Movement in America. By RICHARD T. ELY, Ph.D. of Johns Hopkins University. London: William Heinemann.

Trades Unionism and Socialism have of late become such important factors in the economy of the world that it is no longer prudent for any thinking man to ignore their existence and drift. Literature on these subjects is by no means scarce; almost every leader of working men has written articles, pamphlets and books thereon, and we find a chapter here and there in treatises on political economy, but most of these are somewhat biassed, and therefore do not reveal the true state of affairs. Prof. Ely appears to have studied the labour questions from all points of view, and he is by no means a novice, having already written two books of a kindred nature, viz.: "French and German Socialism" and "The Past and the Present of Political Economy," besides numerous articles in American magazines.

In his preface the author addresses working men, expressing sympathy with many of their movements, not, however, without judicious qualifications: "Much that is done in the name of labour I regard with abhorrence. In the same way should the reader understand my admiration for the Knights of Labour. I believe it is a grand society, but I dissent from some of its principles, and from its course in some localities. Individual knights and individual assemblies have been guilty of outrageous conduct with reference to their employers, the general public, and their fellow workmen. Their deeds have sadly injured the cause of labour." Prof. Ely warns working men against violence: "Destruction of the property or lives of others cannot help you or enrich you. Your triumph can come only by peace. There is much that is bad in existing social arrangements, but there is also much that is good, and this good has been procured by struggles of centuries. With a full appreciation of all that is sad and disheartening in the condition of the masses, I believe that, on the whole, the lot of mankind was never a happier one than to-day." Again: "If your demands are right, if they are reasonable, then you will win, and hold your gain. The world will listen even to socialism, if properly presented. Educate, organise, wait."

The author then discusses with a masterly mind "Early American Communism, The Growth and present Condition of Labour Organisations in America, The Economic Value of Labour Organisations, The Educational Value and other Aspects of Labour Organisation; Co-operation, Modern Socialism, The Socialistic Labour Party, The Strength of Revolutionary Socialism—its Significance," and finally, "Remedies." There is also a copious appendix, setting forth the principles advocated by various associations and labour conventions.

We feel tempted to quote passages from every chapter. The book is full of interest, and it must prove equally instructive to employers, to *employés*, and to students of political economy. We are ever confronted with strikes, and wars between capital and labour. Prof. Ely suggests several remedies worthy of consideration.

VARYING THE FORCE OF AN ELECTRIC DISCHARGE BY DIFFERENTLY COMPRESSED CARBON POWDER DISCOVERED BY MUNCK, OF ROSENSCHOLD, IN 1835.

By A. M. TANNER.

IT has generally been held that du Moncel first discovered the peculiar property which carbon and certain other semi-conductors have of varying their resistance when subjected to a change of pressure. Upon the advent of the Hughes microphone and Edison carbon telephone, the question of priority of discovery of the variable resistance of carbon with pressure was exhaustively discussed in the journals of that period, and the credit of prior discovery was awarded to du Moncel.

During the year 1887 I drew attention, in the *Electrical World*, to the fact that Beetz, in his experiments

made in the year 1861 to test the electrical conductivity of carbon, placed carbon powder or spongy platinum in a glass tube, and subjected it to variable pressure by piston-shaped electrodes in order to obtain a change of resistance. This same method was subsequently embodied in the well-known Clerac carbon rheostat, upon which Edison founded his first carbon telephone. In fact, it would appear that Edison had no knowledge of the earlier experiments of du Moncel, Beetz, and Clerac, when, according to Prescott's work, "The Speaking Telephone, A.D. 1879," he is quoted as saying that he applied to the telephone "the peculiar property which semi-conductors have of varying their resistance with pressure," a fact discovered by him while constructing rheostats in which were employed powdered carbon and plumbago in glass tubes.

I will now proceed to show that the prior discovery of the property that the electrical conductivity of carbon is varied by pressure, is due not to du Moncel, Beetz, Clerac, Edison, or others, but to the Swedish physicist Munck, of Rosenschöld, who published certain experiments on the capacity of solid bodies for conducting electricity in Poggendorff's "Annalen der Physik und Chemie" for 1835, Vol. XXXIV., p. 437. After describing the apparatus used in his experiments, such as a large Leyden jar, and electometers of different capacity, and the action of electrostatic discharges upon various bodies, the author continued, on page 459, as follows, viz.: (Note.—I have endeavoured to translate the German as literally as possible)—

In order to ascertain how carbon powder, variably packed, will be affected by the action of the electrical discharges I placed the calcined carbon mass (obtained by calcining wood carbon in a closed crucible) very loose in the longest glass tube.

The discharge of 25° of the first electrometer was felt at a distance of 13 inches. A discharge of 25° of the second electrometer had no influence upon the conductivity; heavier discharges, however, of 35° to 40° of the quadrant electrometer increased the conductivity, so that the shock of a discharge of 11° was felt at the same distance. After this the carbon powder was taken out, but immediately placed again in the same tube, and moderately packed together. The degree of conductivity was now 20½°, and after strong discharges had been passed through the same, the shock was already felt at 17°. Thereupon the carbon powder was placed in the glass tube for the third time, and very strongly packed. The degree of conductivity was now raised to 33°. By the action of stronger discharges the conductivity was further increased, and the shock of the first electrometer was made perceptible at 16°.

On page 461 the author says that he is of opinion that the phenomenon of the increase of conductivity is due to the change of position, or displacement of the smallest particles or granules of carbon or other material operated upon.

It will readily be seen that Munck, of Rosenschöld, discovered the variation of electrical resistance that carbon powder will undergo when subjected to a change of pressure. It is true he did not use voltaic or current electricity, but discharged a Leyden jar through differently compressed granular or powdered carbon, and he found that the conductivity increased when the granules of carbon were brought in closer contact with each other. This is exactly the principle involved in that class of telephone, and other rheostats where compressible granular or powdered carbon is used.

THE "STELLA" LAMP.

THE following is a translation of a note presented by M. le Comte de Gerson to the Académie des Sciences, and to which we referred last week in our "Notes":—

"The lamp, which is the result of investigations made by an English company, which numbers amongst its members some of the most eminent English savants, has been tested at the Ecole des Mines, and, since, by the mining company at Anzin, in one of its mines the most infected with fire damp.

"The lamp weighs about 1,600 gr., and its illuminating capacity is about that of a candle. It is guaranteed to burn with perfect regularity for a period of 12 hours, but actually it possesses an effective capacity of 14 and even 16 hours' duration. It takes five hours to charge with a current of 1 ampère and 4 volts. It is composed of an accumulator, consisting of two ebonite cells, each of which contains five plates 75 mm. long, by 45 mm. wide, and so arranged as to be protected from exterior shocks. Two of the plates are composed of solid lead peroxide, known as *lithanode*; together they weigh 180 gr., and possess a capacity for useful work of 7 ampère hours. The three others are composed of spongy lead, maintained by a support which is extremely light, and offers a very feeble resistance and a high conductibility; practically it is never used. The more the lithanode is charged the better it becomes, and disunion of the plates never occurs. As there is no contact between the plates, no local action takes place in the accumulator when this is at rest. The total capacity of the accumulator is 28 watt-hours. Thus,

"7 ampère-hours × 4 volts = 28 watt-hours.

"In ordinary mining, the incandescent lamp requires about 5 ampère-hours in 12 hours' lighting.

"The electrolyte used with the accumulator is sulphuric acid diluted, the specific density of which is 1,170.

"The exterior case is of galvanised steel, which is not liable to be rusted by damp. There is a space of about 60 mm. between this and the accumulator; it is padded with rubber, to avoid damage from sparks to the accumulator's ebonite case.

"A little below the centre of the anterior face of the lamp there is a small glass lens, behind which a small incandescent lamp is placed, which, being mounted upon a spring, is drawn into the lamp when the latter receives a shock through the breaking of the first glass. Above the lens there is a commutator, which enables the lamp to be lighted or extinguished at will, so that, in case of a falling in of the works in the rear of the workmen, they would be still in possession of a light for as many times 10 hours as they had lamps.

"The safety is absolute against any imprudence on the part of the miners. Lamps have been broken in gases much more explosive than fire-damp without an explosion. Moreover, the lamp is to be recommended for its simplicity, cheapness, and the duration of its lighting."

THE INDUSTRIAL UTILISATION OF THE COUNTER-ELECTROMOTIVE FORCE OF SELF-INDUCTION.*

By THOMAS D. LOCKWOOD.

IT may as well be confessed at the outset that although my production has cost me considerable thought, it does not claim to advance any original ideas. Its claims to attention are based solely upon its merits as a chronicle. There seems to be among the modern race of electricians not a few who regard that species of counter-electromotive force which is the subject of this paper, as being the only species in the genus. While, of course, this view is erroneous, it is easily accounted for by the notorious fact that the American electrician, as a class, has little time to study. The fact, however, while it is indeed as I have termed it, "notorious," is still to be deplored; for it is certain that were electricians fully informed not only of the researches which took place before their own, together with the results of the said researches, whether these results took the form of success or failure, there would be much less valuable time wasted in supposed original research; there would be far fewer valueless inventions produced; and there would be a much smaller amount of subsequent vexations and useless litigation.

While counter-electromotive force, generally speaking, is a

* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

genus; the counter-electromotive force of self-induction is a species, and while an illustration of this statement will no doubt to most of us be an operation something in the nature of carrying coals to Newcastle, or water to the Mississippi valley, I cannot believe that it will be a waste of time, since doubtless we have many members who have not fully considered the subject.

Consider for a moment a definition of electromotive force. What shall we say it is? It certainly is not a natural force like gravitation, and I do not think we can do better than concede that we call it a force, simply because it is convenient so to do; and define it as any agency tending to set up that form of motion or vibration which we call electricity; or, if you please, any agency tending to the manifestation of electricity.

We are constantly hearing that a current of electricity is the result of a difference of potential between two points connected by a conductor, but though this statement, through constant repetition, has come to be, as it were, "human nature's daily food," I am inclined to consider it as being after all but a mathematical way of saying that a current of electricity is the necessary result of an electromotive force provided with a closed conducting circuit. For it is the electromotive force which first determines the difference of potential, which therefore may be considered as being a kind of initial result. Following out this train of thought, it appears then that electromotive force is a function of the source or instrumentality which develops the current, and expresses the totality of difference of potential in the entire circuit; and while we may properly speak of the difference of potential, or fall of potential between any two points on the circuit, I think we can not with equal propriety speak of the E.M.F., in any other way than as something pertaining to the source.

And further consideration of the same idea shows the incorrectness of the popular phrase often used of late years even by many eminent and able electricians, "a *current* of so many *volts*," the electromotive force being in no sense, near or remote, an attribute of the current.

To run counter to anything is to run against it, to run in opposition to—to act opposedly; and so a "counter electromotive force" may be defined as any agency tending to develop a current of electricity in a circuit, opposite in direction to that of the current excited therein by the initial electromotive force.

A familiar instance is that of connecting up in an electric circuit a certain number of cells in opposition to a number of other cells. This constitutes a primary counter-electromotive force, and its inclusion in the circuit reduces the current in two ways; first, by reducing the acting electromotive force to a value equal only to the algebraic sum of two opposing forces; and, secondly, by adding internal resistance of the value of the cells added in opposition.

Another familiar illustration is found in that ingenious class of dynamo regulator which acts by causing the opposing brushes to creep around the commutator, and, according to the work which is being done in the external circuit, to include in the circuit (by increasing or decreasing the lead of the brushes), a greater or less number of armature coil sections exerting an electromotive force in opposition to the electromotive force which is developing the working current.

In these cases a utilisation is made of counter-electromotive forces deliberately organized for the purpose, but they are not counter-electromotive forces due to self-induction.

At a very early period in the history of voltaic electricity it was discovered that there was some deteriorating force at work in every voltaic battery which depreciated the current to a much greater extent than exhaustion of the liquids or consumption of the solid elements could account for; and, in 1801, Gautherot found* in this phenomenon, which has foolishly been called "polarisation," the germ of the secondary cell. He discovered that wires of platinum or of silver which had been used to decompose salt water acquired a power of themselves, yielding a current when placed in acidulated water, and could cause muscular contractions of a frog's leg, and produce the galvanic test. And subsequently it was ascertained that the operation of a voltaic battery tended to coat the negative plate with hydrogen, which tended to set up a counter-electromotive force between the hydrogen and the surface of said plate, which thus reduced the available energy of the battery, and that this action could be transferred to the electrodes of the same battery, if placed in a separate decomposing cell, and there tended to form electrically opposed surfaces, which could themselves be used to develop a current in a direction opposite to that of the original current. As we all know, this operation, long regarded only as an unmitigated evil, is now utilised in the formation and operation of cells adapted for the electrical storage of energy.

The counter-electromotive force of self-induction distinct from the foregoing, is that discovered by by Prof. Henry; and its most important use is that which has been mainly brought out in association with the employment of alternating or other currents for the purpose of regulation. By reason of the fact that *this* utilisation has proved to be overwhelmingly important, the electrical fraternity has partially lost sight of many earlier and contemporary instances of the useful employment of self-inductive electromotive force; which is indeed a close analogue in its character, mode of generation, and capabilities of use in regulation to that developed and utilised in the operation of electromotors.

* See Izarn's Manual du Galvanisme, Paris, 1804, and Phil. Mag., 1806, Vol. XXIV., p. 185.

Firstly—I desire to point out that though Henry was the first to study and discuss self-induction, he was not the first to notice its effects.

Until quite recently I, together with nearly everyone else, had supposed that the earliest published notice of this phenomenon was Henry's account * of his observation, published in 1832; but I have, in my researches on the subject, dug out the fact that this is not so. I find that an experimentalist, Vassali-Eandi by name, records that,† with a pole of 50 pairs, he found that the fluid passed along a copper wire plated with silver, 1,151 feet in length, in a time incommensurable; the shock in this case was three times as strong as that experienced by immediately touching the two extremities of the pile.

The above isolated statement of facts stands, I believe, alone, and there is no record that it led to further research.

Henry, on the contrary, perseveringly pursued, and made himself master of the subject, and the record of his original observation, brief though it is, details the appearance of a vivid spark on the breaking of a battery circuit, if a wire 30 or 40 feet in length be included in that circuit, shows that the effect is increased by coiling the insulated wire into a helix; and that the effect depends in some measure on the length and thickness of the wire. The note concludes with these remarkable words: "I can account for these phenomena only by supposing the long wire to become charged with electricity, which, by its reaction on itself, projects a spark when the connection is broken."

This, though brief, is then the first analytical notice of the electromotive force of self-induction, so long erroneously denominated after its result, the "extra current."

It is unfortunate that Prof. Henry did not for some time pursue the subject, and we do not hear from him again until March, 1835.

Meanwhile his great contemporary, Faraday, had taken it up, pursuant to an observation of one William Jenkin, and showed self-induction to be a corollary of his former masterly experimental researches in magneto-electro induction.

Faraday notes ‡ the following points: "Self-induction exists in simple helices as well as in electro-magnets, though not to the same degree.

Helices are superior in developing induction to straight wires, and long wires to short ones.

Self-induction practically disappears when the conductor is permitted to inductively act upon a neighbouring closed circuit.

That the amount of self-induction depends on the length of wire exposed to inductive action.

An iron core within helices much exalts the action of self-induction.

The self-inductive effect depends not "upon a permanent state of the core, but on a change of state."

Henry now again takes the matter, and in a consecutive series of papers, practically runs it to earth.

§ In a paper of March, 1835, he gives more in detail, some of the conditions of the development of self-induction. A long wire is better than a short one; a helix better than a straight wire of equal length. He also describes a shocking coil, and also a deflagration coil of but one wire, in which self-induction is involved.

‖ A little later he elucidates the origin and properties of self-induction, and records that some additional energy appeared when iron was used as a core, but not much, because his coils were flat, and not elongated helices. He ascribes all of these effects to dynamical induction, and shows that in a coil of a number of convolutions, the convolutions act inductively on each other, and inferentially that the energy of the self-induction is the sum of that of the different coils.

¶ In a third paper further experiments in self-induction or with the extra current, as it was then called, are discussed. We learn that the electromotive force of any self-induction coil within certain limits is dependent upon the length of the coil.

That the form of the coil has considerable influence on the intensity of the action. In the experiments of Dr. Faraday, a long cylindrical coil of thick copper wire inclosing a rod of soft iron was used.

This form produces the greatest effect when magnetic reaction is employed.

The "extra current" of self-induction developed in a coil is controllable by the presence of an immediately adjacent inde-

* Silliman's American Journal of Science, July, 1832, Vol. XXII., pp. 403—8.

† Philosophical Magazine, Vol. XV., 1803; also Phil. Magazine, Vol. III., 4th series, 1852, p. 455.

‡ Experimental Researches in Electricity, Faraday, 1839, Vol. Ninth series, pp. 332-343, read before the Royal Society, January, 29th, 1835. A series of notes, "The Influence by Induction of an electric current on itself."

§ Journal of the Franklin Institute, March, 1835, Vol. XV., pp. 169-170. Silliman's American Journal of Science, July, 1836, Vol. XXVIII., pp. 327 and 331; and Scientific Writings of J. Henry, Washington, Vol. I., pp. 87-91.

‖ Transactions American Phil. Soc., N. S., Vol. V., pp. 223-231, reprinted in Scientific Writings, J. Henry, Washington, 1886, Vol. I., pp. 92-100.

¶ Transactions of American Phil. Soc., Vol. VI., pp. 303-337, November 2nd, 1838. Silliman's American Journal of Science, March, 1840, Vol. XXXVIII., pp. 209-243. Scient. Writings of Joseph Henry, Washington, 1886, Vol. I., p. 108.

pendent coil. It is energetic when the circuit of the adjacent coil is open, but absent when the adjacent circuit is closed.

Of course it is impossible in this paper even to indicate the many good things which are spread before the reader of the researches of both Faraday and Henry. They are well worth study, and in fact they laid a solid foundation for the work which is being done now.

Both discovery and invention are displayed in their work, much of which has only found its sphere of action within the last four years; for it is emphatically true, as has been said by Mr. W. H. Preece, "that though we are accustomed to hear that necessity is the mother of invention, the child is, as a matter of fact, often born before its parent."

As is frequently the case with electrical discovery, self-induction was for long recognised, that is for the most part, and by the generality of electricians only as an unwelcome guest whose parting was to be speeded.

It was manifested mainly by an undesirable spark appearing upon the break of electric circuits in telegraphic, scientific and medical apparatus, and tending to burn away, or oxidise, contact points; while in the case of the two wire induction coils its effect was to reduce the spark passing between the terminals of the secondary; and many have been the expedients, wise and otherwise, which were devised for its banishment. Many of these were patented, more were not, inasmuch as the fever for patenting everything from a solar system to a thought had not then come into fashion.

Examples of this class of expedient are respectively:—

British Patent, No. 12,772, September 20th, 1849, granted to those old heroes of electric lighting history, Staite and Petrie, which has for its 18th clause a mode of "preventing the spark when breaking contact in galvanic circuits. A thin platinum wire may still convey some portion of the current after the main circuit is broken, or a series of sufficiently long conductors may break contact one after the other." The preferred way, in plain English, was to connect a fine wire as a shunt round the break, and thus to furnish a closed circuit in which the self-induction circulated its current of breaking.

United States Patent, No. 33,269, granted to J. E. Smith, September 10th, 1861, for a means of preventing the spark between the local points of a relay on breaking the circuit—shunting the break by a wire having two terminals dipping into a bottle of water.

Moreover, as is well-known in the ordinary induction coil, the action is emphasised by shunting the primary break by a condenser, as first suggested by Fizeau.*

This, as I shall point out later, is a real instance of the industrial utilisation of self-induction.

Other early investigators in this line reduced the spark of breaking the circuit, by wire shunts also.

Although, as I have stated, the recognitions of self-induction were mostly recognitions of an adversary, there were one or two early instances where the enemy was subjugated, and made to expend his energy usefully. The most notable instances of this are the single wire spark coils of Page and Callan,† which were made especially with a view to exalt the self-inductive effects, and with which metals were fused, and electrolytes were decomposed.

These were the forerunners of the spark coils used at the present day in electric gas lighting, and comprising a single long coil wound to a suitable length upon a long core of iron wires.

There can, however, be no doubt that the principal attempts to make useful the counter-electromotive force of self-induction, and likewise the principal successes achieved, have been in the line of controlling, regulating, or modifying the original, initiatory, or primary currents from which it has been developed.

I have compared this to the transposition of a given number of battery cells.

This analogy is however imperfect, since in cells of battery we may for the sake of argument regard the E.M.F. as being practically constant. Certainly they will in no sense regulate themselves in accordance with conditions automatically, but the inductive resistance *will* do this. For it is dependent for its efficiency as a generator upon the strength of current flowing through it. Therefore, if the current through it due to the impressed electromotive force from any reason falls, the counter-electromotive force will also diminish, and thus will permit a greater amount of the initial force to act; or, in other words, will permit the impressed energy to become more effective. Suppose we have in the main circuit of an alternating dynamo, supplying a number of incandescent lamps in bridges uniting its mains, an adjustable resistance; and suppose the inductive resistance, which we may also regard as a counter E.M.F. generator, to be initially adjusted, so that all of the lamps burn brightly; then within limits of considerable range the current will be kept steady, even though the applied E.M.F. fall or rise, or though the external resistance of the circuit be varied by lighting or extinguishing lamps.

For if lamps be extinguished and their branch circuits be opened, the external resistance rises and the current falls. It is true that the reduced current has not now so many branches to divide through, and that therefore self-regulation even without counter E.M.F. might be expected, but in systems of considerable magnitude it is not found to act practically, as well as it theoretically should. But here the useful effect of our self-induction regulation comes into play; and since the current acting upon the regulator is lowered, it is caused to develop a counter E.M.F. of less value, and thus to oppose less energetically the applied E.M.F., which therefore is brought to a greater extent into action, to overcome the increased resistance, and to maintain the normal current for the remaining work. So, if the applied potential falls, the current in consequence falls with it, and the counter E.M.F. developed falls also, and enables more of the applied E.M.F. to come into action. And the converse is true, if the current in the circuit from any other cause rises. Such an appliance would be still more convenient in connection with an arrangement of arc lamps fed by alternating currents, and connected up in parallel circuit, since the resistance of arc lamps would constantly be changing.

This has been so prominently brought before us by its most modern employment, namely, by its well-nigh involuntary use in the distribution of electricity by means of alternating currents and transformers or converters, having their primaries connected in parallel between the two mains of the source; and by the inductive resistance regulating device, patented by John Hopkinson, in England, August 3rd, 1881, No. 3,362; and in the United States, November 5th, 1889, No. 414,541, that many persons have actually been led to believe that such use is really a new thing.

The employment in the regulation of electrical distribution of counter-electromotive forces set up by the working currents themselves, and proportioning themselves automatically to the work being done, is one of the most valuable and interesting features of modern electrical work; and, though such regulation requires to be supplemented by auxiliary arrangements, and though the belief of some that it could be attained absolutely without any waste has not been completely realised, still by availing ourselves of this feature we are enabled to control electricity with a facility and under conditions which otherwise would be unattainable.

The Hopkinson invention consisted in associating with an arc or glow electric light circuit employing alternating currents, a variable inductive resistance. This in one form was made by coiling a ribbon of thin sheet iron into a ring form, the different layers being separated by an insulating layer, and then by winding a number of coils of insulated wire on this ring, their adjacent ends being connected with plates between which contact plugs could be inserted, so that any number of the coils could be introduced or cut out from the circuit. Another form embodied the same principles, but had not a closed core. This form had a horse-shoe core made of an electro-magnet formed of layers of sheet iron insulated from each other. The legs of the core are surrounded with the coils, and the said core has an armature also made of insulated layers of sheet iron. In this form the armature is clamped down; but the regulability of the appliance is attained by moving the magnet core further into or withdrawing to a greater or less extent from the surrounding coils. The form first described is in the British patent shown as being included in circuit with the two mains of a dynamo; incandescing lamps being in cross bridges between the said mains while in another figure arc lamps are in parallel circuit with mains, an inductive resistance being included in each branch for each lamp, and acting as an equaliser.

The iron core closed on itself to form a complete magnetic ring in which the lines of force are concentrated through the coil, and forced to cut all convolutions when exposed to reversals; the laminations at right angles to the currents, acting to facilitate magnetic change, to diminish hysteresis, and to prevent the circulation of eddy currents; and the insulation of the said laminations aiding in the latter function, all tend to show that this is a very highly organised appliance, and is not only well adapted to produce a very high degree of self-induction, but combines most of the best arrangements tending to that end, and it is therefore not surprising that its invention and use made a strong impression upon the electrical mind, and caused a revival of the idea that regulation on these lines was capable of being accomplished, to use the words of the patent, "without wasting energy." Without materially wasting energy would perhaps be more strictly accurate, for by its use a small amount of actual resistance coil is enabled to do the work of a very much larger amount.

I have certainly no desire to detract from the great merit of this application, but an honest chronicler has no choice, and must say what has been done, and it must therefore be stated that inductive resistances and other self-induction appliances had long been used both experimentally and commercially; no doubt often with but an imperfect conception of their mode of operation.

*Poggendorff's researches into the action of induction coils disclose a remarkable state of affairs for so early a date. These show that one induction coil was employed to send a current through the secondary helices of two others. The first coil thus acted as an alternating generator, and the two others as inductive resistances.

The primaries of two induction coils were connected in parallel and also in series at different times. When, to quote Poggendorff's own words, "two instruments (induction coils) A and B, were so combined that the current traversed the two primary coils one after the other, the induction coils (secondaries), however, were separated, and A was allowed to give sparks, whilst B remained unclosed and without a soft iron core; the

* Comptes Rendus, Vol. XXXVI., p. 418, 1853.
† Sturgeons Annals, Vol. I., pp. 290-302.

*Poggendorff's Annalen, Vol. XCIV., p. 2, and London and Edinburgh and Dublin Phil. Magazine, 1855, Vol. X., 4th series, pp. 136-137.

introduction of the latter into B, weakened the sparks of A, and the subsequent metallic closing of B reproduced their former strength."

The proper arrangement of induction coils is then discussed, and whether the primaries should be connected in series or in parallel circuit. It is shown that the latter way is the proper one, and why. Then the paper goes on to say; "With respect to the cause of these phenomena, it is no doubt to be sought in the extra or inner induction current. The outer induction current, which is produced by breaking the inducing current, has the same direction as the latter; whereas the extra current, which is at the same time excited in the induction wire, whose tendency is to weaken the first induction current, and the more so the stronger the extra current, which latter is especially strengthened by the soft iron core.

"Consequently, when the primary coils of A and B are connected one after the other, it is clear that the insertion of the soft iron core into that of B will strengthen the extra current in that of A, and therefore weaken the induction current of the latter instrument.

"By connecting the instruments side by side, a closed circle is at once formed by them, and the extra current produced by the insertion of the soft iron core into B acts against that in A, and may, therefore, when both are equal, completely neutralise it, when the outer induction current of A will necessarily be strengthened.

"Without the circle formed by this combination, *i.e.*, in the wire leading back to the voltaic battery, the two extra currents act of course in the same direction, and strengthen one another, in consequence of which the sparks at the current breaker are still very active."

These considerations of Poggendorff show that even at this early period a great flash of light was thrown into the darkness, which hitherto had obscured the reactions of self-induction, and though we have largely failed to use that light until quite recently, this is chiefly attributable to the same oft-recurring reason, that there was really little call for it; hence it was soon hid under the bushel of the results of research on other subjects of more immediate interest.

The statement which I last quoted brings me again to the application by Fizeau of the condenser as a shunt to the vibratory brake, and to its operation.

* As shown by Lord Rayleigh, the condenser operates by producing electrical oscillations, and in its action the spark at the contact breaker is greatly decreased, and the spark between the secondary terminals greatly magnified, because at the break the condenser is virtually an inductive reservoir, being an electrostatic shunt. And being an electrostatic shunt, the energy it momentarily absorbs is returned reversely to the primary circuit, just as in the discharge of a secondary cell, and increases the inductive variation in the secondary circuit during the brief period of time immediately after the break. And as the electromotive force in the secondary is thus exalted, it is not difficult to see why the condenser increases the sparking distance.

As early as December 6th, 1862, a patent for cable working, No. 3,453, was taken out by C. F. Varley, which describes the use of a self-induction resistance. This patent says: "A second circuit from the cable to the earth, independent of the receiving instrument, is formed by means of a resistance coil with a large iron core. It may be advisable to connect the cable to earth through an induction coil, consisting of a large bundle of iron wire, surrounded by a long length of fine wire, the action of which is as follows: On reversing the battery connections, the induction plates (condenser) and battery combined, send a short impulse into the cable, which divides; one portion into the cable, the other through the induction coil to the earth. At the first moment, the iron of the core opposes the passage of the current, consequently during the first instant of time nearly the whole force of the current is applied to the cable. As the iron becomes magnetised to its maximum, this opposition ceases, but the plates have been charged in the opposite direction, and there is no longer any current passing from them into the cable to maintain the magnetisation of the iron; the demagnetisation of which induces a current in the coil and discharges the cable. In this way each impulse is followed by a short impulse in the opposite direction. One of the figures of the patent shows that the wires of the core are made long, and are turned back on all sides over the wire of the coil, so as to entirely encase it. This feature was in conformity with a previous British patent, No. 3,059, of 1856. The arrangement, however, clearly shows a use of a self-induction coil as a current controller, and indicates the function of a large iron core.

We next find the counter E.M.F. of self-induction coming into use in connection with fast telegraph systems. Arrangements for its use are shown in the United States patents granted to Mr. Edison. These are, respectively, No. 135,531, of February 4th, 1873; No. 141,773, of August 12th, 1873; and No. 147,313, of February 10th, 1874.

The first and second disclose a shunt circuit, including an electro-magnet connected round the receiving instrument of a chemical telegraph. The first also shows a leak to earth from the line, which leak includes an electro-magnet. In both cases the object is to utilise the discharge current developed by the electro-magnet in the regulation of the operation, and to produce sharp and clear signals.

The third describes the use of electro-magnets in shunt circuits round the transmitting and receiving instruments of an automatic telegraph system, and is said to be an improvement on the first. A number of electro-magnets are shown, and by means of a switch one or more of these may be introduced. In other words, the inductive resistance is here adjustable, and is operated by breaks, not by reversals.

British patent, No. 3,935, November 14th, 1874, to Alexander Melville Clark for a chemical copying telegraph, uses induction and other coils to clear a line by the self-inductive counter E.M.F. By the decrement or cessation of the impulse (as the patent states) the strongest depolarising effects are produced, and the line is successfully cleared.

Next come four other patents to Thos. A. Edison. These are U.S. patent, No. 168,243, of September 28th, 1875, for an automatic telegraph. This, as in the previous cases, employs an electro-magnetic shunt.

U.S. patent, No. 168,385, of October 5th, 1875, duplex telegraph. This is an excellent example of self-inductive regulation. The counter E.M.F. is developed from electro-magnets in a changing electric circuit, and the coils have cores closed on themselves.

The next two, No. 173,718, of February 22nd, 1876, for automatic telegraphy; and No. 178,221, May 30th, 1876, Duplex Telegraphy, involve no new principles, and are like the preceding ones.

* Much information regarding the subject, and further examples of its practical application, can be found in a particularly able paper on "Shunts," read by William H. Preece, before the Society of Telegraph Engineers in 1887. The subject of the counter E.M.F. developed in electro-magnets is discussed, and the increase of the same, when the iron core is endless, is determined and pointed out; a good many instances of the practical uses of the self-induction shunt are described.

U.S. Patent, No. 207,724, of September 3rd, 1878, granted to Thos. A. Edison for a duplex telegraph, shows an electro-magnetic coil and closed magnetic circuit core placed in each branch of a Wheatstone bridge duplex telegraph, to counteract by its counter E.M.F. of self-induction the discharge of the electro-magnets in the bridge circuit. In Culley's Handbook of Practical Telegraphy, London, 1878, pp. 303 to 304, also pp. 305 and 411, the regulation of currents by inductive resistances is considered.

In the first instance, the counter E.M.F. of an adjustable series of electro-magnetic coils is used to delay the discharge of a condenser in a duplex system. This is closely analogous to the function of the Hopkinson device, and is very suggestive. The reference on page 305 states that "static discharge can be entirely compensated for by the use of an induction coil, or a series of electro-magnets, instead of a condenser."

U.S. Patent, No. 227,039, of April 27th, 1880, to Muirhead and Winter, for a quadruplex telegraph, describes electro-magnetic shunts for reversing keys and relays, which are to counteract, by their discharges, electrostatic retardation. The specification says: "The electro-magnets may be of the well-known closed horseshoe form, or they may consist of a single rod of soft iron, with flanges of soft iron, and a cylindrical casing of iron closing over the wire, and connecting magnetically flange with flange.

U.S. Patent, No. 231,904, September 7th, 1880, to Joseph E. Fenn, duplex telegraph, uses an electro-magnetic generator of counter E.M.F. in the line circuit to counteract effects of discharge. It is made with a closed magnetic circuit, a separate coil being on each leg of a multiple pole core; several of these poles are made with yokes, and the combined yokes can be made magnetically continuous or discontinuous at will by means of iron plugs, which can unite the different sections of core.

A book published in 1880, by Louis Schwendler, and entitled: "Instructions for testing telegraph lines, and the Technical Arrangements of Circuits," Vol. II., pp. 144-147, gives a description of an electro-magnetic shunt and its operation. It is made like an ordinary electro-magnet, but has an adjustable wedge-shaped armature in contact with the cores. This, of course, operates by utilising the counter E.M.F. of self-induction, which develops currents that circulate through the shunt, and sharpen the signals.

In telephony, also, as in other fast systems employing rhythmical currents, the counter E.M.F. has by no means been idle. As in telegraphy, our early acquaintance with it was an unpleasant one. Many of the earlier telephone lines connected with a number of stations, and at each station there was, of course, an electro-magnet to operate the call. In some cases this was a telegraph relay, and in other cases a bell magnet. But in either case it was found, as, indeed, might have been anticipated, that the telephone currents had a decided repugnance to pass through the intervening electro-magnets on their way from one station to the other. To quote the graphic words of one of the patentees of devices intended as remedies for this trouble, it was found that electro-magnets were, to a large extent, "opaque to telephone currents."

Of course this is due to self-induction. The resistance of the line or the magnet coils had little or nothing to do with it. The convolutions, however, had, since it is clear that the electromotive force of the self-induction was proportional within certain limits to the number of convolutions.

The same difficulty appeared also in exchange work, where between any two connected lines was interposed an annunciator, to give from either end station a disconnecting signal. Several

* Phil. Mag., Vol. XXXIX., p. 428, et seq.

* Journal of Society of Telegraph Engineers, London, 1877, pp. 40-69.

devices have been suggested for the removal of this difficulty, and some of them have been patented.

Elisha Gray shunts the several interposed magnets by condensers: *vide* United States Patent, 203,264, of May 7th, 1878.

F. W. Jones, attacking the same difficulty, shunts the interposed magnet by a non-inductive resistance controlled by the armature of the signalling magnet. See United States Patents, 238,399, of March 1st, 1881, and 238,912, of March 15th, 1881.

Other devices have also acted to shunt the bell or annunciator magnets in different ways; and still other suggestions have been to surround the iron core with a brass sleeve, or with a closed circuit consisting of one layer of insulated wire; but these last, while certainly reducing the retardation, reduce also the magnetic power of the appliance. And there is no remedy so effectual as the absence of the interposed electro-magnet.

The service rendered by self-induction in telephony, and that which still may be expected, fortunately will probably outweigh the ills which it introduces. In many switchboard installations for metallic circuits, the supervising telephones are looped or bridged across between the two conducting links which unite one of the two metallic circuits with the other, and their self-induction prevents a material loss of current. Where from some condition of the service, such, for example, as the requirement of supervising both metallic and earth return circuits at the same switchboard, it sometimes becomes necessary in bridging the telephones to attach an earth branch to the connecting link on one side of the instruments; in this case it has also been found necessary in practice to place coils containing iron cores on the other side of the earth branch, so that not only the resistance, but also the self-induction, may be balanced.

It has also been ascertained that many telephones can at different stations be placed across from one wire to the other of a metallic circuit, without any perceptible diminution of the effect at any one of them. This is one of the most important results of self-regulating attribute of self-induction.

Perhaps, however, the most valuable instance of turning an electrical enemy into an electrical ally, is the way in which by the proper use, construction, and arrangement of electro-magnets, a plurality of either telephonic, or partially telephonic and partly telegraphic messages, may be transmitted over the same circuit at the same time.

The pioneer in this kind of work was C. F. Varley, who as early as 1870 took out a patent, No. 1,044, in England, for a combined simultaneous ordinary Morse and harmonic Morse transmission over the same wire; in this system the straight Morse was worked through electro-magnets, while the harmonic branches were led off from the main line from points outside of the electro-magnets.

Carrying on this line of invention, Mr. Van Rysselberghe, of Belgium, and Dr. Roseburgh, of Toronto, Canada, have worked out systems whereby telegraphy and speaking telephony can be at the same time operated over the same circuit.

Since, however, there is enough in either system to fill up a paper devoted to them exclusively, and since this paper is already too long, I find it impossible here to describe them in detail, reserving this possibly for some future occasion.

Self-induction has also been caused to aid in eliminating the disturbing results of extraneous induction caused by parallel circuits, as in the United States patent of Mr. Edison, No. 203,019, of April 30th, 1878, where a telephone circuit is freed from external influences by combining it with an induction coil connected with the disturbing circuits in such a manner that the direct disturbances received in virtue of the parallelism of the contiguous circuits is neutralised by an equal and opposite induction received also from them through the induction coil. This, however, is not a practical expedient.

Closely analogous to the self-inductive regulation of which I have been speaking, is that upon which the efficiency of an electro-motor depends. This was first observed by Jacobi,* who says:—

"Experimenting on the magnetic force of a bar of soft iron, I sometimes found considerable differences for which I could in no way account. I was curious to know if these differences proceeded from the nature of the iron, or from the weakening of the electric current produced by a voltaic pair of half a foot square of surface. For this reason, I placed in the circuit a galvanometer so distant as not to be affected by the direct magnetism of the bar. I was much astonished to see the needle recoil on placing the armature, and advance on removing it, for it was the first time I had known the double quality of the connecting wire, viz., that of constructing the voltaic current, and at the same time representing an ordinary wire subject to the action of a magnet in motion. The spiral producing a magnet by the voltaic current is at the same time a magnetic electrical spiral in which a magnet is placed.

Hence the solution of the uniform velocity of the magnetic machine. For being set in motion by the magnetising power of a voltaic current, it represents simultaneously an apparatus composed of magnets in motion, and capable of producing a magnetic electrical current in a direction opposite to that of the voltaic current."

Jacobi, in a subsequent paper, practically elucidated the principles of the operation of counter E.M.F. in electro-motors, even as now understood, although he possibly did not state them as we now would. But he clearly showed that a motor may be regarded as a dynamo acting to develop an electromotive force, opposite in direction to that acting upon it, E. That the resultant force was of course E e, and that this, together with the resistance of circuit, determine the strength of the current. That the motor utilises $C e$ of the electrical power supplied $C E$; and he furthermore showed that the power developed by the motor, $C e$, is at it its maximum when e equals one-half E.

It may be thought by some that, considering the title of the paper, the principal utilisation to which I have referred, viz., the use in regulation of systems of alternating currents operating converters should have been discussed. It does not seem to me that it is necessary; this has often been done, and will again often be done by others much more competent than myself to handle the subject. But it does seem right that one should be found to give due credit for those who in the same line of thought are "not lost, but gone before," and I am glad that I am in a position so to do.

There seems little need for me to cite any more instances, showing that, like nearly all new arts, the art of regulation by means of self-induction and of otherwise usefully employing the counter E.M.F. due thereto, is not *quite* new, and that while we can congratulate ourselves upon the achievements of the present, we should not fail to respect the foundation layers of the past, for, of a truth, there were giants in those days.

* Sturgeon's Annals of Electricity, 1837, Vol. I., pp. 408-419.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

6867. "Improvements in holders for incandescent electric lamps." C. RICHARDSON and G. HILL. Dated April 24. 6d. Claim:—In an electric incandescent lamp-holder or other like fitting, the use of a piece of insulating material of the form of a cylinder with two deep flats, one on each side, or further to be described as shaped in the nature of two washers joined together by a stout web, substantially as shown and described.

7774. "Improvements in means for supplying electric current to road vehicles, boats, and the like." R. C. SAYER. Dated May 4. 8d. In the case of tramcars and vehicles on public roadways, or canal or other boats, the electric current to work their motors is conveyed to them by means of similar line conductors explained in patent application No. 3,487, A.D. 1889, but the wheels are to be inverted and the conductors carried above the vehicles or boats, the latter (the conductors) are to be deepened to act as longitudinal continuous girders when desired for long spans, and reduced to compound wires or cables when desired for short spans or to prevent obstruction. 3 claims.

7808. "An electric alarm attachment for pressure, vacuum, speed, and other gauges." A. JULIAN. Dated May 10. 6d. Claim:—An attachment to pressure, vacuum, speed, and other gauges for sounding an alarm by means of electricity.

8453. "Improvements in regulating electric currents." W. M. MORDEY. Dated May 21. 8d. The apparatus consists of three principal parts, the relay, the regulator, and the resistance or other device required to be moved, controlled, or varied. The relay consists of a core and solenoid arrangement preferably comprising two fixed hollow wooden bobbins wound with wire, and placed vertically and parallel, and having a U-shaped core freely suspended and entering the bobbins from below. The core is of laminated iron or iron wire, to increase its sensitiveness by reducing reactions to a minimum, especially when used with alternate currents. This core controls a contact-maker of any suitable form. 3 claims.

8493. "Improvements in automatic cut-outs for electrical circuits." W. J. STARKEY BARBER-STARKEY. Dated May 22. 8d. The inventor includes a small dynamo or magneto-electric motor in a high resistance shunt from the dynamo or mains. By means of stops or other devices he limits the possible angular motion of the armature of this electro-motor so that it may not rotate continuously whilst its circuit is closed. The spindle of the armature is geared or connected with a switch or device, such as a mercury or brush contact, for opening and closing the main circuit. 7 claims.

9096. "Improvements in telephonic switchboards." H. F. JACKSON and D. SINCLAIR. Dated June 1. 8d. In lieu of a switchboard having the portion which carries the line jacks placed in a vertical position over a single switch table carrying the usual indicators, cords, switches, and other accessories used by the operators in calling and making connections between subscribers, the inventors form a duplex switchboard in which the part carrying the line jacks is laid horizontally between switch tables on two opposite sides, and each provided with indicators, cords, and other usual accessories, so that operators placed at both switch tables may use the same board to make connections to all the subscribers from any of the two different sets of subscribers whose calls they attend. 4 claims.

9182. "Improvements in apparatus or devices for switching or diverting electric currents, more especially intended for use with telephonic circuits." A. GRAHAM. Dated June 3. 11d. Has more especially for its object to provide an arrangement of switching board and devices for telephonic circuits, whereby they can be used for switching or diverting the currents, whatever the arrangement of the circuits may be. 5 claims.

9183. "An improved exciting liquid for electric batteries." Dated June 3. 4d. M. SUSSMANN. Claims:—1. An exciting liquid for electric batteries, consisting of a solution of ferric chloride to which zinc chloride is added. 2. The addition of the chloride of that metal of which the electrode consists to the solution of the ferric chloride.

9294. "Improvements in and relating to dynamo-electric machines and electric motors." H. H. LAKE. (Communicated from abroad by C. S. Bradley, of America.) Dated June 4. 1s. 1d. Consists in an electric motor or dynamo-electric machine of any class to which the invention is applicable, having its field magnets energised by currents induced in the mass of the magnet itself as distinguished from the magnetism produced in the field magnet by a current or currents circulating in insulated conductors wound upon the magnet. The invention further consists in the construction and arrangement of parts for the above ends, and the combination of devices used in starting and operating the motor. 22 claims.

9713. "Improvements in electric conductors." J. G. LORRAIN, (Communicated from abroad by La Société d'Exploitation des Cables Electriques, Système Berthoud, Borel, et Compagnie, of Switzerland.) Dated June 12. 6d. The inventor takes a core of any of the usual forms, and upon this he winds in the same direction of progressive revolution two ribbons of paper or the like, one of which ribbons is half a width in advance of the other, so as to effect what is known to engineers as "breaking joint." Over the covering thus formed he winds a second serving consisting as before of two ribbons arranged so as to break joint: but in the case of this serving the direction of winding is the opposite to that of the winding of the first serving. In this manner he proceeds until a sufficient number of servings has been put on to give the desired thickness of dielectric. 3 claims.

9723. "Improvements in grids or containers for the elements or plates of secondary batteries, and moulds to be used in their manufacture." THE ELECTRICAL POWER STORAGE COMPANY and P. J. REA. Dated June 12. 8d. According to this invention a mould or chill is provided for the casting of secondary battery grids or containers for the active material or materials to be rendered active, by means of which the grid is so formed that the material with which the holes therein are to be filled is not liable to split or fall away. 2 claims.

10440. "Improvements in holders for incandescent electric lamps." H. BAYLEY. Dated June 27. 8d. Has for its object simple means for facilitating the attachment and disconnnection of the head or cap of a holder for an incandescent electric lamp, and the socket or case thereof for the purpose of wiring the holder. 3 claims.

10556. "An improved manufacture of flexible electric cable." W. E. GRAY. Dated June 29. 6d. The inventor provides a metallic core consisting of a bundle of fine copper wires slightly twisted; this he covers with insulating material, then braids over the insulating material in the usual way. The cable thus far made is enveloped in a flexible metallic sheathing composed of, say, twelve strands of steel or iron wire, each strand being composed of, say, seven wires, No. 20 gauge, specially compounded. This flexible sheathing is covered with a suitable tape, and after coating this with a preservative compound, the cable is completed by braiding upon it a strong covering of hemp or jute. 1 claim.

10699. "Apparatus for automatically regulating the potential in the conductors for two or more sets of electrical lamps." SIEMENS BROTHERS AND COMPANY. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 2. 8d. Relates to means of automatically regulating the potential in the conductors for two or more sets of electrical lamps, when two or more sets of lamps are connected in series, and the conductors are so arranged that all of them, except the two end ones, are common to two sets of lamps. 1 claim.

10933. "Improvements in electro-motors." M. VON DOLIVO-DOBROWOLSKY and the ALLGEMEINE ELECTRICITATS-GESELLSCHAFT. Dated July 6. 8d. Claim:—In a secondary electric machine the combination with a magnetic field of an armature composed of an iron body of rotation, bars, strips, or wires of copper arranged transverely to the direction of rotation of the machine, and also transversely to the lines of force of the magnetic field and copper conductors, whereby the said bars, strips, or wires are connected together at both ends, substantially as described.

11049. "Improvements in dynamo-electric machines, in part applicable to electro-motors." J. J. WOOD. Dated July 9. 1s. 1d. Consists, firstly, in an improved method of winding the armature, whereby the short-circuiting of the armature coils within themselves is prevented; and, secondly, in improved means for effecting the automatic regulation of the current generated, in order to maintain it at a uniform volume. 3 claims.

11832. "Improvements in junctions or couplers for electrical conductors." F. R. DOLBY. Dated July 25. 6d. The inventor forms one or more parts or all the parts of the couplers, so that a current of electricity may be passed round them or through them in order to magnetise such part or parts, which will be made of some magnetisable material, the object being to cause the parts of the coupler to be attracted to one another, and so cause a grip, and at the same time by such pressure to make good contact for the passage of the current or currents through the conductors thus joined together. 2 claims.

12773. "Improvements in apparatus used for electric railways." F. WHEELER. (Under International Convention.) Dated January 14. 8d. Consists in constructing a trolley, which, when applied to line conductors suitably supported, cannot, without intention, be removed therefrom. To attain this object the inventor employs in connection with two line conductors or wires, supported at intervals by brackets, the arms of which extend from the centre outward, a trolley, the wheels or rollers of which are supported from the outside of said conductors. 6 claims.

12901. "Improved means for supporting and separating the plates of electric accumulators." R. E. B. CROMPTON. Dated August 15. 6d. The plates in the cell rest on two lines of supports, each line of supports consists of two bars placed at convenient distance apart, and notched on their upper surface to receive the plates in alternate order, so that the whole of the positives rest on one bar, and the negatives on the other bar. When viewed from the side the edges of these bars are cut away between the notches, so that the alternate plates pass over them and clear of any possible contact with them. The connecting pieces which separate the two bars in relation to one another are so arranged that in every case vertical surfaces only, on which no deposit can rest, are interposed between the notches which carry the two sets of plates. 3 claims.

13322. "Improvements in the means or apparatus for transmitting electric signals." E. J. P. MERCADIER. Dated August 23. 8d. Consists of:—1. A vibrating body of suitable form, as, for example, a spring plate or a diapason, the vibrations of which are maintained electrically by the complete or partial automatic interruption of an electric current traversing one or more electro-magnets situated in the vicinity of the vibrating body. 2. One or more coils or bobbins, with soft iron core placed in the magnetic field of the electro-magnets, and connected together in series or for quantity. 3 claims.

17088. "Improvement in means for operating mechanical devices electrically, specially applicable to electric meters, electro-motors, electric lamps, and electric cut-outs." W. E. IRISH. Dated October 29. 1s. 1d. Consists in the utilisation of a rod or strip of metal, composing an integral part of the circuit, and affected to expansion or contraction by the passage of the current to operate devices for switching, regulating, and measuring the electrical current, in connection with suitable connecting mechanism. 29 claims.

20660. "An improved electric signalling apparatus." J. O. WINCKLER. Dated December 23. 6d. The object of this invention is to enable miners during their ascent or descent of the mine to give electric signals to the engineer from the cage or lift, as to whether he is to stop, lower, or wind up, also to indicate to the engineer the speed of travel of the cage by electric bell signals. 1 claim.

CORRESPONDENCE.

Prof. Elihu Thomson's Alternator.

This machine possesses some interesting features. But is not the theory, as put forward by the American journals, erroneous? Are there any lines of force moved, except in so far as they are brought into existence and made to vary in intensity? It seems to me that the production of current in this case essentially depends on the inductive effect arising from change or variability of magnetism. The variability—for there is no absolute change of magnetism in any part of this machine—is caused by periodically opening and closing a series of magnetic circuits. If a longitudinal section of one half of the machine be considered, it will be seen that the magnetic circuit so formed is alternately closed and only partially opened by the star-shaped armature, so that the resultant current would be proportional to difference between iron and air as magnetic mediums; the break in the magnetic continuity making the necessary magnetic change; and as this break is only partial, depending on the depth of the cavities between the projections of the star-shaped armature, there is neither cessation or reversal of magnetism. Would it not be more correct to call the machine a mechanical transformer?

E. L. Voice.

August 23rd, 1890.

We notice in your publication of August 15th an account of Prof. Thomson's latest dynamo.

It is apparent from the enclosed description of Pyke and Barnett's machine, of which we hold the patents,

that there is a considerable similarity, although their patents cover far more than Prof. Thomson's in the equalisation of the field magnets. The poles of Prof. Thomson's machine have not so much chance of obtaining saturation as ours, as they are only partially covered for an inappreciable period of time. When the inductors are between cogs, the field is partly varied, but in Pyke and Barnett's patents the field is equally closed, so that there is less strain on the inductors, and less pulsation of the shaft, and no loss due to heating, whereas, in Prof. Thomson's machine, it is apparent that there is considerable loss from heating in the field, more particularly the inner revolving part of the same; but in Pyke and Barnett's there is ample space for ventilation.

Pyke and Harris.

August 26th, 1890.

Electric Traction.

We have your issue of August 1st, and note, on page 128, your article about our company, and what our cars are doing at Beverly, Mass. Yes, you are "gravely assured" that every word in the article in the *Boston Post* is as stated; and we further believe the last six lines of your article to be true. We have *proved* every point and stand ready to, and are perfectly sure we can, convince anyone of all these statements. If we have all this it is worth looking into, is it not? We advise you to do so. We hand you herewith cuts of our trucks, cars, power house, &c.

Union Electric Car Co.,
By JOHN H. ALLEY, *Vice-President.*

Boston, *August 11th*, 1890.

[We can only insert this letter and advise our readers, especially Messrs. Holroyd Smith, Reckenzaun, Elieson, Lineff, &c., to refer back to our issue of August 1st.—EDS. ELEC. REV.]

Electrical Endosmosis or Cataphoric Medication.

I am sure that now a prominent electrician like Mr. Edison has spoken on this subject, it will receive the attention it deserves. But the subject has really been before the medical profession for a considerable time, first, as a well-known physiological experiment, and for twelve months at least as a matter of practical application by myself, and doubtless by others.

I showed cases of rheumatoid arthritis and other diseases, under treatment by this method, at a lecture given to my mixed class of medical men and nurses at the Institute of Medical Electricity on November 5th, 1889; I spoke on the subject at the December meeting of the Brussels medical graduates (1889), and on December 11th of the same year I published a paper in the *Medical Press and Circular*, giving in some detail my plan of using the process.

I hope shortly to publish a *series* of cases treated by cataphoric medication, though I have hitherto refrained from doing so, inasmuch as it is unwise to draw conclusions from a single case of any particular disease, or even from a limited number of such cases. I have preferred to wait until circumstances enabled me to bring forward a sufficient number of results.

Arthur Harries, M.D.

August 25th, 1890.

Cable Testing.

Considering my youth, inexperience, and past discourtesy, I ought to be deeply grateful that the editors of so learned and scientific a journal as the ELECTRICAL REVIEW should have sacrificed more than two pages of their invaluable space to my mental improvement; but, strange as it may appear, I recognise in this action less of good nature than of a desire to find material to fill the columns of their paper.

Clever as the editors of the ELECTRICAL REVIEW have always shown themselves at forecasting events (notably in the case of the Marchant engine, which was to "revolutionise the electric lighting industry"), their prophecy that I should regret having sent them my communication has, contrary (?) to precedent, not been fulfilled, for I am still so deluded as to think that I have not described a method of testing which is so very commonly known, or so ancient as some people would have me believe.

On first seeing such well-known names as Kempe, Webb and Varley appended to letters stating the absolute antiquity of my method, remembering Virgil's sententious lines,

> Sum pietate gravem ae meritis si forte virium quem
> Conspexere, silent arrectisque auribus adstant,

I felt inclined to abstain from further comment; but after carefully perusing their letters, I have come to the conclusion that a different course is open to me.

Mr. Kempe says that the method I have described is old, and so obvious as not to require description in any text-book.

I cannot see that my method is any more obvious than Warren's method, yet the latter, which has the great disadvantage of necessitating the cutting of the outside sheath of the cable a large number of times for each fault localised, and which, consequently, is not so expeditious as my method, is described at considerable length in Mr. Kempe's and other text-books. Moreover, it seems strange that in the columns of "The Philosophical Magazine," so recently as 1879, attention should have been drawn to Warren's method, when, according to Mr. Kempe, a method was then already very generally known, which involved no cutting of the outside sheath of the cable.

I have very little to say to Mr. Varley's letter beyond remarking that he has entirely missed the point at issue. The method which he describes, and which, by the way, he evidently considers reflects considerable credit upon its inventor, despite its being, according to Mr. Kempe, so obvious as to need no description, is of course perfectly applicable to G.P. covered wires. If, however, the leads had been covered with tape or felt, the method which Mr. Varley describes would have been of no use.

Another correspondent, whose name is withheld from publication (a procedure which I imagined was contrary to the rules of the ELECTRICAL REVIEW), refers me to Culley for a description of the original method of fault-finding by passing lead through an insulated trough. This gentleman seems to think that my method, and the one described in Culley, are identical. If he will take the trouble to read a little further, he will find that the above is not the case, for Culley, having described the method of testing with a trough, goes on to say: "To find a fault in a very highly insulated sheathing, *covered with a good conductor*, Hooper's material, for instance . . . . the tape is carefully removed over a space of 6 inches," &c., describing, in fact, Warren's method, to which reference has already been made. My test is certainly not indicated in Culley, as special mention is there made of a method to be adopted (involving cutting of the outside sheath) where the faulty cable is insulated with sheathing covered with a good conductor.

The copy of Kempe's "Electrical Testing," which is in my possession, contains no account of Mr. Jacob's method; the latter has, however, been described to me, and, so far as my memory serves me, I believe it to differ from my own in several essential points. Should, however, this not be the case, my position will be considerably strengthened, for it appears that Mr. Kempe has thought it worth his while to publish this test in his latest edition of "Electrical Testing," which he surely would not have done had the method been so obvious, so ancient, and a matter of such common knowledge as he, in his letter, states it to be.

H. Cuthbert Hall.